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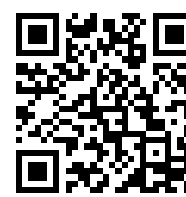

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CONTENTS.

PAGE

The History and Traditions of the Royal Artillery. (A lecture delivered at the Royal Artillery Institution on Wednesday, 20th March, 1918). By Col. E. A. P. Hobday, C.M.G., R.A. Major-Genl. W. F. Cleeve, C.B., R.A., Comdt. R.M.A. in the Chair. 1

Indoor Gunnery. By Major B. J. T. Ford, R.F.A. (T.) 24

Prussia's Part in the Seven Year's War. (A lecture delivered at the Royal Artillery Institution, Thursday, 21st March, 1918). By Brig.-Genl. F. G. Stone, C.M.G., *psc.*, R.A. Major-Genl. W. F. Cleeve, C.B., R.A., Comdt. R.M.A. in the Chair. 28

A Useful Accessory to Miniature Ranges. By Temp. Major W. H. Wilson, D.S.O., R.F.A. 39

Prècis of Revue Militaire Suisse. By Capt. G. de L. Landon, M.C., R.A. 40

Horse Management in the Field. A Lecture delivered at the Royal Artillery Institution, Thursday, 14th March, 1918. By Colonel E. A. P. Hobday, C.M.G., R.A. Brig.-Genl. A. Stokes, C.B., C.M.G., D.S.O., R.A. in the Chair. 41

Relative Calibration by the Corrector. By Capt. B. M. G. Butterworth, M.C., R.G.A. 60

The Gunners Rule. By Sagittarius. 63

The 'Bearing' Method of Laying for Line. By Temp. Capt. L. A. Notcutt, M.C., R.G.A. 65

Locating Positions on Maps. By Major J. Powrie, R.H.A., (H.A.C.). 69

Surveys of the English Coast 1779-1793. From records of reports made by the Inspector of Royal Artillery on the Coast Defences of England. By Major A. E. Macrae, *pac.*, R.A. 73

"Brain re Rule of Thumb." (A Reply). By Major A. E. C. Myers, R.G.A. 87

Prècis of Revue Militaire Suisse. By Capt. de L. Landon, M.C., R.A. 88

Surveys of the English Coast 1779-1793. From records of reports made by the Inspector of Royal Artillery on the Coast Defences of England. By Major A. E. Macrae, *pac.*, R.A., continued from page 86. 89

Calculations necessary for the Construction of Dug-outs and Gun Pits. By Temp. Maj. F. M. G. DuPlat-Taylor, R.G.A. 107

Notes on the Identification of Points. By Capt. K. F. W. Dunn, R.F.A. 117

"Flying".—An Explanation 120

The Modern Attack on an Entrenched Position. By Colonel H. A. Bethell, C.M.G., R.F.A. 121

398010

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1

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PAGE

Comparative Calibration in the Field. By Major C. Q. L. Penrose, M.C., R.G.A. 130
Drift with the 4·5″ Howitzer. By Major L. E. Booth, M.C., R.F.A. 134
Ranging on the Line of Observation without the use of Factors. By Bt. Col. A. ff. Powell, D.S.O., R.A. 136
The Long Range Gun. A Lecture delivered at the Royal Artillery Institution, Monday, 13th May, 1918. By Major J. Maitland-Addison, R.A. Brig.-Genl. A. Stokes, C.B., C.M.G., D.S.O., R.A. in the Chair. 137
Notes on the Errors of Vertical Base Range-Finders. By Lieut. A. Hutchison, Clyde R.G.A. (T.) 151
The Distribution of the Energy contained in a Cordite Charge for ·303-in. Mk. VII Cartridge. By Major J. H. Hardcastle, *pac.* (late) R.A., R. of O. 157
Displacement Corrections. By Lieut. P. W. F. Brown, R.G.A. 164
Driving Band Gauges. By Lieut. P. W. F. Brown, R.G.A. ... 164
Liaison. By A. G. C. 165
The Simplest and most Accurate Form of Grid. By Major E. H. Lovell, R.G.A. 169
Sport in Mesopotamia. By Brig.-Genl. H. J. A. Mackey, C.M.G., M.V.O., D.S.O. 173
Short Chronology of events connected with the *matériel* of Artillery, down to the year 1886. By Lieut.-Col. H. W. L. Hime. 175
Ranging on the Line of Observation. By Temp. 2nd Lieut. J. P. Campbell, R.F.A. 178
Distribution or Concentration Rule. By Temp. 2nd Lieut. J. P. Campbell, R.F.A. 180
The Gunner's Rule. By "Newly Fledged". 182
The Gunner's Rule. By Sagittarius Secundus. 185
Ready Reckoner for Wind Corrections. By 2nd Lieut. F. G. Witts, R.G.A. 186
Built-in Beams in Dug Outs. By Temp. Lieut. E. S. Stanley, R.G.A. 188
Sums in the Field. By Major S. R. Wason, M.C., R.H.A. ... 189
Oblique Observation. By Major S. R. Wason, M.C., R.H.A. ... 197
Notes on the use of Major Swayne's Sheets. By Major C. E. Hare, M.C., R.G.A. 201
Simplest Form of Field Plotter for Quick Work in the Field. (Position on Map Being unknown). By Bt.-Col. A. ff. Powell, D.S.O., R.G.A. 203
Correction to Range when Firing with Angle of Sight. By 2nd Lieut. F. G. Soper, R.G.A. 205
Ordnance on the Allied Front. Developments in Artillery During the War. By Major-General J. E. W. Headlam, C.B., D.S.O., in Charge of the British Artillery Mission to America. 209
Ordre General No. 351. Q.G. le 16 Juillet, 1918. 221

Digitized by Google

PAGE

Artillery Instruments not of Service Type. By Major L. A. Notcutt, M.C., R.A. 222
Remarks on Trench Artillery. From the United States "Field Artillery Journal". January—March, 1918. 245
The Economic Effort of the Central Empires. Translated from "L'Europe Nouvelle," 24 August, 1918. Communicated by Temp. Major F. M. G. Du Plat-Taylor, R.G.A. 251
The Journal of the Royal Artillery. 253
Actions Performed by the Artillery of the Fifth Army. By Major-Genl. H. C. C. Uniacke, C.B., C.M.G. 255
A Simple Apparatus for Instructing Gunlayers. By Capt. R. V. Walling, R.G.A. (T.). 283
The Section Commander. By Major-General H. C. C. Uniacke, C.B., C.M.G. 285
A Note on Ranging with Aeroplane Observation. By Major R. B. Withers, D.S.O., R.G.A. 287
Extracts from Report on Operations. August 21st—September 4th, 1918. Communicated by Major-General H. C. C. Uniacke, C.B., C.M.G. 289
The Official Entry of the Fifth Army Commander into Lille, on 28th October, 1918. 292
The Taking of Jerusalem. By A Battery Commander 295
Artillery Training. Communicated. (Continued on page 350).... 301
Artillery Graph. By Lieut. H. J. Fisher, Australian Field Artillery 314
An Appreciation. Genl. Sir Robert Biddulph, G.C.B., G.C.M.G., Colonel Commandant, Royal Artillery. Master Gunner, St. James's Park. Born 26 Aug., 1835. Died in London, 18 Nov., 1918. 317
Remarks on the Vice-President's Appeal to the Members R.A.I. By Lieut.-Colonel H. W. L. Hime. 323
Echoes from the Mess Table—and elsewhere. By "Henry Clay" 325
What is a Nomogram? By Lt.-Col. R. K. Hezlet, D.S.O., R.A. 330
Tactical Exercises Without Troops. By Major-Genl. H. C. C. Uniacke, C.B., C.M.G. 334
The German Invasion of England. Xth to XVIth Centuries. By Brig.-General F. G. Stone, C.M.G. 338
Artillery Training. Communicated. (Continued from No. 9, page 314). 350
With the Field Artillery from Trench to Open Warfare on the Western Front. By Lieut.-Colonel W. H. F. Weber, D.S.O., R.F.A. 357
Echoes from the Mess Table—and elsewhere. No. II. By "Henry Clay". 363
The Battle in Palestine. Commencing August 19th, 1918, as seen from the R.G.A. advancing in support of the Left Flank. By Lieut.-Colonel F. P. Hutchinson, D.S.O., R.G.A. 370
Gaudia Centurionis or The Instructor of Zeitûn. Illustrations by Major J. F. Fogerty, R.F.A. (T.). Verses by Lieut. H. C. Hughes, R.F.A. (T.). 375

Digitized by Google

PAGE

The Employment of Officers in Topographical Surveying. By Major R. H. Rowe, D.S.O., M.C., R.G.A. 387
"A Tough Lot." By Major General J. B. Richardson, Col. Comdt., R.A. 390
Artillery Pack Saddlery. By Capt. (actg. Major) F. C. A. Troup, R.G.A. 393
The Rapid Calculation of Switches from an O.P. without a map. By Major S. R. Normand, D.S.O., R.G.A. 397
Some Old Gunnery Experiments. By Major T. W. Saidler, R.G.A. (T.). 402

Digitized by Google

List of Inserted Maps, Plates, &c.

(Additional to those in the Letterpress).

TO FACE PAGE.

Plate to illustrate "A useful accessory to Miniature Ranges. 40

Figure 1 to illustrate "The long range gun." 138

2 „ „ 140

3 „ „ 140

4 „ „ 144

5 „ „ 146

6 „ „ 146

Diagram to illustrate "The distribution of the energy contained in a Cordite Charge for ·303-in. Mk. VII Cartridge." 162

Diagram to illustrate "The simplest and most accurate form of grid." 172

Diagram to illustrate "Simplest form of Field Plotter for quick work in the Field." 204

Table to accompany "Artillery instruments not of Service Type" 236

Plate to accompany "Artillery Graph" 316

Portrait of Genl. Sir Robert Biddulph, G.C.B., G.C.M.G., Colonel Commandant, Royal Artillery. Master Gunner, St. James's Park. 317

Map to illustrate "The battle in Palestine." 372

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Contents of R.A. Journal, April, 1918.

The History and Traditions of the Royal Artillery. (A lecture delivered at the Royal Artillery Institution on Wednesday, 20th March, 1918). By Col. E. A. P. Hobday, C.M.G., R.A. Major-Genl. W. F. Cleeve, C.B., R.A., Comdt. R.M.A. in the Chair. 1

Indoor Gunnery. By Major B. J. T. Ford, R.F.A. (T). 24

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A Useful Accessory to Miniature Ranges. By Temp. Major W. H. Wilson, D.S.O., R.F.A. 39

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Prècis of Revue Militaire Suisse. By Capt. G. de L. Landon, M.C., R.A. 40

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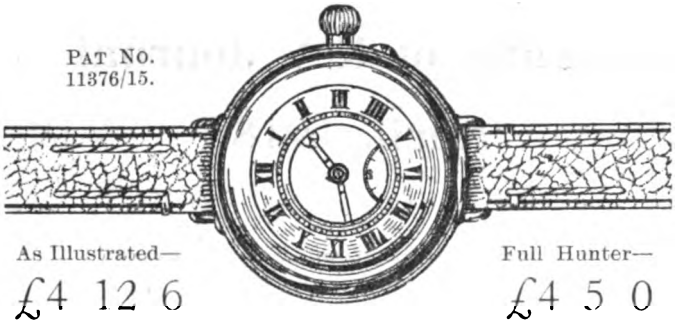

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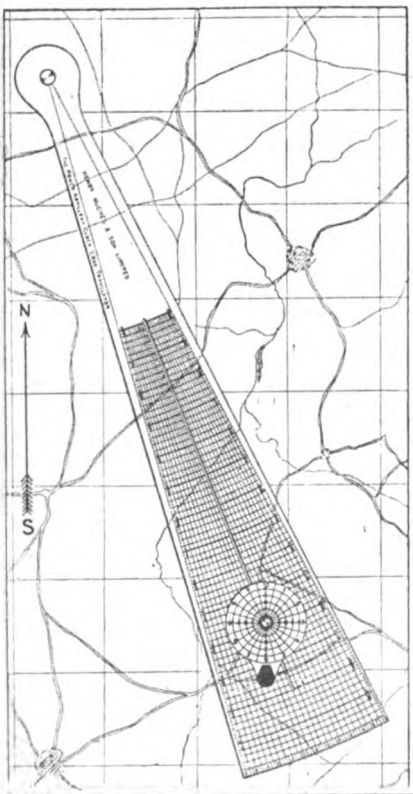

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THE HISTORY AND TRADITIONS OF THE ROYAL ARTILLERY.

A lecture delivered at the Royal Artillery Institution on Wednesday, 20th March, 1918.

By Colonel E. A. P. Hobday, C.M.G., R.A

Maj.-Genl. W. F. Cleeve, C.B., R.A., Comdt. R.M.A. in the Chair.

NOTE.—This lecture was compiled largely from memories of Duncan's, Hime's and Leslie's works while on service in France, and has been frequently given to Officers and N.C.O's at many of the Artillery Schools of the various Armies. The lack of access to works of reference must be my excuse for any errors or inaccuracies it may contain.—E.A.P.H.

THE CHAIRMAN: Ladies and Gentlemen: I have much pleasure in introducing Colonel Hobday, the Lecturer, to those of you who have not had the pleasure of knowing him before. He is going to speak upon a very interesting subject as rendered by him, and I am simply going to ask him to go on with his lecture.

Col. Hobday: General Cleeve, Ladies and Gentlemen: The history of our Regiment is a subject of interest to all its officers, whether permanently or temporarily connected with the artillery. We have got a very glorious and a very long history behind us—the British Artillery. I am not talking of the Royal Regiment alone but of British Artillery, because we had Artillery before the Royal Regiment was formed, and it is a good thing for all of us whenever we can get the chance to study any Histories, records or pamphlets of any description which relate to the doings of our predecessors. There is a lot to be learned from them; and the good work which we have done in recent campaigns, and the splendid way in which our gunners have behaved in this war, as in all others, is largely founded upon the good spirit which the tradition of the Regiment has fostered. British Artillery has always done well. I might mention amongst other authorities that if you get the chance you should read Duncan's History of the Royal Artillery; read Colonel Hime's pamphlets and books on the Regiment, read Colonel Jocelyn, read many of those notes and records which were compiled and edited by my old friend Major John Leslie, who is our most untiring historian, and always interested in everything connected with the Regiment. If you come across Diaries like Mercer's Diary of the Waterloo Campaign, or books like "England's Artillerymen" by Corpl. Browne of the R.A. Band, these will give you lots of interesting reading. Any how you cannot go wrong in learning all you can about what has been done by the gunners of old days, and how our corps has been evolved and developed.

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As I said before, British Artillery is older than the Royal Regiment. British Artillery dates back from the time when cannon were first used with drivers in the field. We began to use cannon in warfare somewhere about the 14th Century. It is believed that Edward II used cannon in his invasion of Scotland at the siege of Stirling Castle; but we know for certain that cannon were used at the Battle of Crecy in 1346 against the mail clad knights of the French exactly in the same way that they were used hundreds of years afterwards at Waterloo against the French Cuirassiers. The old cannon were very curious things. The first cannon were made of bars of iron hooped together, some of them even of wood; some fired darts, and others fired balls or grape shot. Of course the rude cannon of that day could not stand very large charges or very heavy shot. Some guns were even made of leather. A little later we learnt the art of casting cannon, and I may remind you that the British Artillery has always been to the fore in artillery science and research. A great many most useful inventions in connection with artillery have originated in England. Early in the 13th Century, gunpowder was first discovered in Europe by one Roger Bacon, a monk at Ilchester. Then later on we find lots of inventions, of which I will tell you as I go along, that have been originated in the English Artillery or in England; so that our good name for scientific research and the improvement of guns and munitions, has always been pre-eminent among the nations of Europe. Now in those days there were iron foundries in Sussex; they got the iron ore there, and they had forests which they used for making fires for smelting the ore at the iron foundry and making charcoal. If you read "Puck of Pook's Hill" by Kipling one of his stories speaks of the old cannon foundries in Sussex. There was a cannon founder named Collet, a famous artilleryman of those times and he made guns for Henry VII and Henry VIII, I think.

Gradually guns began to be standardised into a certain type and we had that long period of what I will call the "tube and touch-hole" period of muzzle loading artillery, which lasted right down to the time when I joined the service about forty years ago. Roughly speaking every gun was of this type—a bore with a touch-hole (drawing a sketch on the blackboard). The bores began to be rifled in the 19th century. It was soon found that a very good material for casting cannon was gun-metal, that is brass and tin mixed, and gun-metal or brass, and cast iron were the materials of which all artillery was cast for hundreds of years.

In the old days our gunners used to be very rough and ready in their methods of loading and serving the piece. They used to have powder barrels near the gun and in the old prints you see a very curious thing, something like a magnified cheese scoop, with which they ladled the powder out of the barrel and put it down the bore of the gun and then put in a wad, with a stone shot, or whatever the projectile was, on the top. It was found as time went on that it was more convenient to have the charges not so rough and ready but made of something like equal weight, so as to get more uniform results in range and powder, and they then used to put the charges in bags after weighing them out. The bags were generally

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made of some easily combustible material like serge or flannel. After loading the gun you primed it at the vent or touch-hole with a horn of powder and touched the priming off with a slow-match or a red-hot poker or in later years with a port fire.

Now there was a very curious thing connected with the drill of muzzle loaders, although I cannot vouch for it, I think it must have been one of the oldest traditions of the Regiment. I got it from some old drill sergeants in the days when I was a cadet and a young officer. You see when the cartridge was rammed home, number two, the man with the rammer stood in front of the gun wheel, and number four was behind the wheel on the same side. After the cartridge was rammed home the shot was put in the bore and rammed home on the top of it. One danger of premature explosion was that little bits of the old cartridge case might be left smouldering in the bore and when you rammed home the cartridge, it created a draught up through the touch-hole unless that was stopped there; so that No. 4's duty was to put his thumb on the touch-hole (it was called "serving the vent") to stop that draught so that there should be no chance of any little bits of smouldering stuff flaming up and setting light to that cartridge, and blowing off the arms of the man who was ramming home in front of the muzzle. I heard it laid down several times by the drill sergeant in the old days that if No. 2 did not see that No. 4 was serving the vent when he rammed the cartridge home he had a perfect right to hit him as hard as he could over the head with the rammer. Now I should very much like to know if any other officer ever heard that. It is quite possible that it is a very old tradition that has come down orally for many hundreds of years, ever since muzzle loaders were first used, although it would not be included in any Drill Book. There was another curious custom connected with artillery in the old wars. When a city was taken by siege or assault, the artillery commander of the victorious army was entitled to the church bells of the place as his perquisite. They were often redeemed by a money payment. The idea probably was, that the bells being made of bronze or gun metal they could be melted down and cast into cannon for the use of the artillery.

In the 16th and 17th Centuries the classes of cannon in use were as follows. The heaviest type of gun was the Cannon-royal, which threw a shot of 24lbs. or thereabouts, then came the culverin a 12 to 18-pr. piece—the demi-culverin was a 9-pr.—the Serpentine and Saker were 4 to 6-pr. field pieces and the Falconet smaller still. The predecessor of the mortar was the Bombard. The oldest existing piece of British Artillery is a Bombard of the 14th Century found in the moat of Bodiam Castle in Kent. It is now in the Rotunda at Woolwich. The good old artillery rank of Bombardier originally applied only to men who served with Bombards and was not an N.C.O's grade.

Now we come to the organisation of artillery. Artillery is one of the oldest services under the crown, because we are connected with and are descended from a Department which now has somewhat different duties to what it used to have, that is the Ordnance Department. The Master General of the Ordnance is one of the oldest offices in the kingdom, and the Master General of the Ordnance had

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charge of all artillery material, guns an ammunition, and these were kept stored in the old fortresses, like the Tower of London, Tilbury Fort, Dover Castle, and later on Landguard Fort and other places. The Master General of the Ordnance also managed all Engineer services, and the Sappers like ourselves, have developed from the old Ordnance Service, and we must always remember how closely we are related to them as the Sister Scientific Corps. Many of the early artillery companies were formed from "companies of miners" and similar units. Engineer officers too have always been educated at the R.M.A. Woolwich as cadets.

There was no regular Establishment of Artillery kept up in peace except the small detachments of gunners in these old forts who were trained men in charge of the Ordnance stored there. They used to make and prove the guns, make experiments and improvements in gunnery and ammunition, and teach recruits when necessary all gunnery duties.

The old Ordnance Depôts were under the charge of "Master Gunners" and many of these have left very interesting works on artillery matters showing that they were men of scientific knowledge. Amongst others Bourne, Eldred, and Hye wrote treaties on gunnery matters in the 16th and early part of the 17th centuries.

Those old permanent gunners were the forerunners of our Garrison Artillery, who can thus legitimately claim to be the oldest permanent corps under the Crown. There is nothing else in the British Army at the present moment that can date back further than Henry VIII when the Yeomen of the Guard were formed. Most of the army dates from after the Civil War. These old gunners go right back to Queen Elizabeth's time at least and probably before that; they were enlisted for life, and it is on record that some of them at Tilbury Fort were from 60 to 90 odd years of age in Elizabeth's day so that you can realize they were really long service men.

What was the procedure in these old days? If there was a War, the Master General of the Ordnance was ordered to form a "Train of Artillery," and, according to the force employed and the requirements, whether it was at home or abroad or for siege or field work, he pulled his guns out of store and got his master gunners to train recruits from the Infantry Corps, or raw levies, officers were appointed and the "Train of Artillery" was formed. That system lasted well into the 18th century. It lasted through all our old wars under William III and Queen Anne and Marlborough's campaigns, and for those wars when you wanted mobile artillery, such mobility as you could get in those days, the horses were all hired and the drivers were hired too. The guns went into the field with the drivers who were simply yokels off the farms with their smocks and slouch hats and carters whips, and probably the only thing they had by way of uniform was a bit of ribbon to distinguish them. These countrymen led the big cart horses with the guns into the field and when the guns took up their positions they seldom moved much during a battle. The artillery soon became an important and technical arm, difficult to improvise, and the principle of having to make up a new train of artillery at the beginning of a war and disband it at the end of a war was found to be very wasteful and expensive, and as we had wars

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and campaigns coming pretty quickly one after the other at the end of the 17th and beginning of the 18th centuries, it became necessary to have a permanent force of artillery ready for emergencies and fit to take the field at once. It was found especially inconvenient after Marlborough's campaigns were over when the armies came home and nearly all the artillery was disbanded. A Rebellion suddenly broke out in Scotland in 1715. There was no proper force of artillery ready and what artillery they sent to the front had to be very hastily improvised, and altogether the artillery organization in the campaign of the Rebellion was a failure. So the great Duke of Marlborough, who was then Master General of the Ordnance, was told to raise a permanent force of artillery and in 1716 (remember that date—it is a great Regimental date) the Regiment was born as a permanent unit. Two companies were then formed. A few years later, 1722, the title "Royal Artillery" was given to it. I believe a few artillery units claim that they can date their origin previous to 1716, but probably that means that possibly they may have been, as shown by records, formed for Marlborough's Wars in the early years of the 18th Century and had not been disbanded before 1716, but officially 22nd May 1716 is the birth of the Regiment. That is when the Warrant was issued for the formation of the Regiment as a permanent force and in 1722 it became the Royal Artillery.

Now who was the first Commandant? He was a Danish officer named Albert Borgard who had fought long and well all over Europe, and in the wars under Marlborough in the Low Countries, who had been through goodness knows how many battles and sieges, and he was made the first Colonel Commandant of the Royal Artillery. What were those original companies like? They were commanded by a Captain; they had a second Captain usually attached to them (the rank of Major did not exist then in the Artillery), then they had Lieutenants and they had some other peculiar ranks. They had what were called Lieutenant fire-workers. Now the name denotes its duties, the Lieutenant fire-worker looked after the explosives, and he was in command of the men, they called fire-workers, who were in charge of the ammunition. Then there were gunners. Now the gunners duties were solely confined to the loading and firing of the pieces. Besides the fire-workers who looked after the ammunition, there was another grade among the rank and file who had a name which is peculiarly interesting now we are at war with Germany. They were called "Matrosses." In Germany to this day "Matrosen" are sailors; the sailors of the German Fleet are "Matrosen", so that our word "matrosses" is very curious. When you hear what their duties were you will realise how the word came across from Germany or Holland and was adopted by us. The "matrosses" were men who did all the block and tackle and "repository" work, all the business with handspikes, and so on, and when the gun had to be taken along by hand, they did the hauling work on the drag ropes. You can see now how their affinity to the German "matrosen" comes in; they were the handymen, they did more or less sailors work. The matross had a slightly lower rate of pay than the "gunner".

We will go on now from 1716. After Albert Borgard died, the first British Commandant of the Royal Regiment was named Jonas

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Watson. He was a very fine soldier, and had also served in all the principal battles and sieges of Marlborough's campaigns in the Low Countries. I was lucky enough when in France near Bethune in the summer of 1916 to come across a great curiosity associated with him. The day after Bethune was heavily shelled by the Germans I was in the town and I visited an old curiosity shop I knew of and I found a lot of very interesting old prints of fortresses and towns in Flanders and France, and plans of sieges of Marlborough's campaigns. Amongts them was a chart of the siege of Bethune, the very place I was in, when it was a French Fortress, besieged in 1710 by a German General, Count Schulenberg, with a British Contingent. Now that siege of Bethune in 1710 was one of Jonas Watson's sieges, and on the print was marked all the positions of the British batteries which he commanded there. I bought that print and sent it home to my friend Major John Leslie who has it now, and it was a very interesting thing to find at that time in the very place. I will tell you another thing about Jonas Watson which will show you what a fine old soldier he was. You were not "run out" for age in those days in the way you are now, and Jonas Watson lived to be a very old man in the Regiment. There was an Expedition sent to the West Indies under Admiral Anson to capture a lot of the Spanish possessions there, and with the troops which were being sent out they proposed to send a certain amount of artillery, and the Master General of the Ordnance wrote to Jonas Watson asking him to name and recommend some officer whom he considered the most experienced and best fitted for the command of the artillery in that Expedition. Jonas Watson wrote back a letter of about four lines saying that he could find nobody more experienced or better fitted for command of the gunners than himself, and he went. He was over 70 at the time; he was killed by a round shot at the siege of Portobello in the West Indies, a fine old soldier and a brave gunner.

Now we will get on a little bit. We have got the Regiment born and started. Companies were added from time to time and in 1741 they started a training school for young officers at a place known as the Warren near Woolwich, which was the origin of the Royal Military Academy. The Royal Military Academy itself was started in 1764 and cadets were trained there for the regiment before becoming officers.

From time to time the companies were largely added to, as we were fighting in that wonderful 18th century all over Europe and all over the world and we soon found that the reputation of the British Royal Artillery grew tremendously. The battle where the Royal Artillery really "found" itself and the Field Artillery may be said to have become a mobile branch (though not yet distinct) and showed what good co-operation with Infantry meant, was at the famous Battle of Minden in 1759. Now a very high authority, General Scharnhorst, a Prussian General, at the end of the 18th century, said that the British Artillery had everything to do with the victory at Minden where they were specially thanked by the Prince of Brunswick. Minden is chiefly celebrated for a wonderful feat which was performed there by six British Infantry Regiments. It used to be thought that the only way in which Infantry could withstand an

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attack of cavalry was to form square, and oppose an impenetrable hedge of bayonets so that the cavalry could not break them; but in this battle of Minden there was arrayed against our six foot regiments the flower of the French Household Cavalry, the Mousquetaires and the Garde du Corps and all the famous *regiments d'élite* and they attacked our infantry. The infantry not only received them in line but beat them off and followed them up in line and eventually dispersed them. For that success they were largely indebted to the British Artillery under Forbes Macbean, George Phillips, Drummond, and other good artillery leaders of that day who commanded the guns in that battle. In those days when guns were grouped in action, what we would now call a battery was termed a "brigade of guns".

Phillips had a group of 12 guns at Minden which engaged in a duel with a French battery of 30 guns and absolutely silenced it only losing two of their own guns. When the infantry advanced the artillery advanced with them; they were becoming mobile, their drivers were mounted, and when the French cavalry tried to re-form after the infantry drove them off the artillery fire broke them up and drove them off the field. At a battle not long after Minden, Warburg, George Phillips brought his artillery on to the field at a gallop, and that is the first time we hear of extreme mobility. Mind you, the Horse Artillery were not in existence at that time, but Phillips advanced at the gallop, showing the great strides that had been made from the time when the guns were taken into action with the lumbering led carthorses of the Marlborough period. By the way Phillips was the originator of the first R.A. Band. Up till the great war with France the companies of artillery had no special armament; they were merely companies, and they were armed and their duties varied according to the conditions under which they were used. If they were garrisoned somewhere, they did garrison duty; if they were in a campaign they were issued with field equipment and hired horses were given to them and they went into the field with them. It was not until much later that the duties become specialized as Horse, Field, Garrison and Mountain.

The next memorable feat of arms we hear of in connection with the artillery is the great defence of Gibraltar in a four years siege which lasted from 1779 to 1782. The Spaniards had always been very jealous of our possession of Gibraltar, which was captured from them by Admiral Rooke in Queen Anne's Reign. In George II time the Spaniards and the French made an alliance and gathered a large fleet and a powerful army and they determined to recapture Gibraltar. We were very weak at sea in the Mediterranean then and they were able to drive our fleet away, and Gibraltar was blockaded by land and sea. The siege dragged on and about the third year of the siege the French and Spaniards made a very special effort, they thought they would spring a great surprise on us and have a tremendous attack in which the Fortress must fall. The surprise that they sprung on us was nearly as great as the surprise of the tanks the other day which we sprang on the Germans. In this case it was some special bomb-vessels they invented; they cut down men-of-war and made compartments in them which they filled with sand which they thought would stop our shot, and then they had

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a penthouse roof over them covered with raw hides kept watered, and they thought that these would prevent them being set on fire. They put as heavy guns as they could on these vessels; they thought that these bomb vessels were to be the last word in warfare and that we would be absolutely pulverised and our defences broken to pieces by them. In our artillery garrison at Gibraltar there were a certain number of German and Hanoverian artillery. You must remember that the Georges were Kings of Hanover as well as Kings of England, and every British army then included a certain number of Hanoverian troops. When Napoleon overran Europe and took Hanover most of them came over to England and became the famous "King's German Legion" and helped us in the Peninsula and Waterloo, but at Gibraltar a certain number of German gunners were part of the garrison and the senior officer at that time was also a German. His name was Major Kohler, and I will tell you a curious thing about him in connection with the siege of Gibraltar. In 1903 and 1904 I was the artillery representative on the Committee of the Royal Military Tournament, which used to be held then annually at Islington. They used every year to give some sort of pageant with historical uniforms and in 1904 they asked me to arrange the pageant for that year or similar display. I said "I will do it if you will allow me to do it as a Historical record of my own regiment, and with my own people," and we got up a very interesting show of the British Artillery from the earliest days, the days of Crecy, in which men and horses were taken from R.A. units within reach of London. I think I ransacked every print shop in London and learned a lot of most interesting details about regimental dress and equipment and things of that sort. Macdonald's Book, which you know, about the dress of the Regiment was also very useful. We got permission to use the real guns of every period represented, from Museums and Arsenals. We got them from the Rotunda, the Tower of London, the United Service Institution and all sorts of places, but the only gun we showed I think that was not the real gun of the period was a copy and it was a model of a garrison gun of the Siege of Gibraltar period. This was a gun the carriage of which had been specially invented by Major Kohler for firing down at an extreme depression from the highest batteries of the Rock onto the bomb vessels in the sea below. That gun carriage and gun were made by the artillery college here in Woolwich from Major Kohler's own drawings and original sketches which are in the Institution here now. This was the idea: the front of the carriage was cut away and there was a big arc at the back *here* which enabled the gun to be depressed to an extreme like that (describing by a sketch). Major Kohler made a great feature of the method of firing red hot shot. That was his answer to these wonderful bomb vessels. Every gun had a furnace alongside. They loaded the cartridge, then put a very thick wad in so that the red hot shot should not burn through quickly on to the powder; then the red hot shot was dropped in, another wad put in to keep it in place, the gun was depressed and touched off as quickly as possible. There is a very interesting engraving now in the ante-room of the Institution showing one of the batteries during the siege of Gibraltar, with General Elliott, (who became Lord Heathfield and was always known

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as "The Cock of the Rock") who was Commandant at Gibraltar then, and Major Kohler pointing out and showing him the gun being fired. It was entirely owing to the good work of the British Artillery that that attack was beaten off. These bomb vessels proved a failure, one after another was either sunk or set on fire, and the attack which lasted some two or three days absolutely collapsed. The only other thing of note which happened in the siege was a splendid sortie by the garrison in which the gunners took their share; they went out and destroyed all the enemies batteries on the land side, and, although the siege dragged on for nearly another year, it was really all over and Gibraltar was saved, largely owing to the good work of the British Artillery.

We come now to the threshold of the great period when the artillery developed enormously, and that was the long war which began with Revolutionary France in 1793 and which lasted almost without a break till Napoleon's defeat at Waterloo in 1815. At the opening of that campaign the Duke of Richmond was Master General of the Ordnance and we had a number of very able gunners who improved our ordnance and did a lot of good scientific work at that time. There was Congreve, who was a great scientific artilleryman and who introduced a lot of improvements of importance into our artillery. He was the man who invented the tangent sight which was adopted by all the nations of Europe afterwards. He also invented the block trail for artillery. For a long time guns had a very cumbersome arrangement like that (making a sketch); you know the sort of heavy double bracket trail. That was very bad because the carriage had to make a tremendous arc to turn in. He invented the single block trail like that (making a sketch), and he also equalized the size of the wheels for the gun carriage and limber, so that they were interchangable. The elevating screw which replaced the clumsy quoins or wedges previously used in laying the gun, was, I think a French invention. Congreve had an equally clever son whom I shall mention later. There were others Miller, Dundas, Blomfield and several others who introduced a lot of good improvements into the regiment, but in the beginning of that French War the greatest development we had was the birth of a new arm of the artillery, and that was the Horse Artillery. Now horse artillery had been used already by the East India Company's Troops. There was horse artillery in India a very short time before we had them in England, and it originated from light guns being used with cavalry. They were called Galloper guns and accompanied the cavalry and fought with them, but it was soon found more convenient to group the guns into Batteries of Horse Artillery whose gunners were mounted and could keep pace with the cavalry. Horse artillery were always styled "troops" and all other artillery were called companies. You will find that in the old British Army Units were very seldom known by numbers or letters but were generally distinguished by the name of their Commanding Officer. We find in the Infantry Cutt's or Handysides Battalion, and in the Artillery you will find Ross' Troop of Horse Artillery, you will find Lawson's Company of Artillery and all those other Troops and Companies were generally known by their C.O's names.

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The first "troop" formed in 1793—'A' Troop, is now the "Chestnut Battery" of the R.H.A. It was engaged in the Low Countries in 1793 and was very severely handled. It suffered very heavy casualties and went home to refit, and was next engaged in the Irish Rebellion in 1798, but the troops were added to and many of them made great names for themselves. They were "lettered" from 'A' onwards as formed. The old system of hiring horses and drivers was also done away with about this time, and a "Driver Corps" with its own officers, formed. They supplied the animals with mobile artillery companies.

We come now to the Peninsular War which as you know, lasted from 1808 to 1814; the regiment made a famous name there which ought always to be remembered by all of us. Lawson's Company, the one I mentioned to you just now, was the only British Artillery Unit that was through the whole of the campaign from the very beginning to the end, 1808 to 1814; it was in almost every great action. We soon had some splendid troops of Horse Artillery besides the Chestnut Troop which was Ross' Troop. There was Bull's Troop now "I" Battery, there were Downman's ('B' Troop) which did good work in the Corunna Campaign, and Whinyate's and several others Robe and May were also good Field Artillerymen of that period. There were lots of splendid actions in that war. You have all heard of Norman Ramsay's great feat, where he saved two guns of Bull's Troop. Napier has a fine piece of writing about it in his history of the war, but he is wrong in saying that it was Ramsay's battery. Norman Ramsay was Bull's Second Captain, that is Second in Command of his troop, and at the battle of Fuentes d'Onor (1811) he was detached on the right with two guns. The battle of Fuentes d'Onor was roughly this sort of thing; Wellington's position was on a ridge which extended from his left to the village of Fuentes d'Onor and then bent back at right angles towards his rear. Our line dipped down to the plain and ended in some small villages on our extreme right, and a little stream ran across our whole front with the French position on the far side of it. Fuentes d'Onor was about our centre. The first day of the battle, May 4th, Massena attacked our left. Fuentes was taken and retaken several times but remained in our hands at nightfall. Now Massena was very strong in cavalry, much stronger than we were, and next day he thought he would use his cavalry to outflank us in the open country on the plain on our right, so he sent forward all his cavalry and they came on in large masses, till the whole plain was covered with them. Wellington saw that his only chance of real safety was to throw back his right flank from *here* to *here* and he ordered the retirement on to our ridge *there*. The infantry retired in squares across the plain like that (making a sketch) with masses of French cavalry, riding all round them and trying to break up the squares, but they went back very steadily aided by charges from our own cavalry. Norman Ramsay had been *here* near the villages on our extreme right. At the opening of the battle of the 5th May, he did not notice at first what was going on, so he remained there a bit too long, and by the time he tried to get away all the French cavalry were between him and our retiring infantry. He started to retire, trotting along between the squadrons and regiments of French cavalry but presently he was seen and the

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French cavalry, concentrated en masse upon him. There was a large cloud of dust caused by the converging cavalry, and as Napier says, presently the French cavalry seemed to be gathered together at one point where the crack of pistols and the flash of sword blades showed that something important was happening. Presently the mass was rent asunder and Norman Ramsay appeared at the head of his guns, the teams stretching like greyhounds over the plain, with the guns bounding behind them like things of no weight while the mounted gunners followed in mad career. Anyhow what Norman Ramsay did was to put his section at full gallop at the French cavalry and go right through them. He had his gunners on the outside and in rear to prevent the cavalrymen coming in and cutting down the drivers. He was very much helped by some timely charges by the 14th Light Dragoons and the Royals, but that does not take away from the marvellous character of the feat, and from that time to this the 5th May is always kept as a holiday in "I" Battery in which I have had the honour to serve.

Another great piece of artillery work in the Peninsular War happened at the Siege of San Sebastian. Towards the end of the war we drove the French out of the Peninsula after defeating them at Vittoria in 1813 and they tried to defend the Pyrenees against us. Near the Pyrenees there is the fortress and harbour of San Sebastian and Wellington had to take that before he could operate against them in the Pyrenees, because he wanted to make a new supply base of it being nearer to England than Lisbon. The town is built on a rocky promontory like *this*, with a bay on one side of it, and there is a castle on the top of the hill *here* and *here* are bastions and fortifications, with the town in the middle (making a sketch). The head of this little bay is almost dry at low tide, it is very shallow and the British siege batteries were mostly out *here* along the sides of the bay, and there were a few *here* on the Isthmus. The British artillery, as in most of the sieges and battles of the later part of the Peninsular Campaign, were commanded by a very famous gunner, Sir Alexander Dickson. I may as well tell you now a little more about him. Alexander Dickson was chosen over the heads of a lot of senior officers by Lord Wellington to be his C.R.A. in the Peninsula, you must remember that the artillery and also the Engineers were still under the Ordnance Department as distinguished from, the War Office, for a long time, till after the battle of Waterloo in fact, and Wellington found that when he had to deal with the Ordnance Department in artillery matters they were a bit "red tapey" and slow or obstructive, and he could not get on with them, and none of the C.R.A's that they sent him could do what he wanted. Now Alexander Dickson had made a good name in organizing the Portuguese artillery: he had the reputation of being a man who made no difficulties, he never made any trouble about anything and whatever he was asked to do, he said "Yes I will get it done", and he did it. Wellington promoted him to be his C.R.A. and he commanded the artillery in all the great sieges and battles during the latter part of the Peninsular War. You will see all his decorations and Sword of Honor in the Institution here. He commanded the R.A. at the Siege of San Sebastian. Now when the breaches in the walls were

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considered practicable we assaulted San Sebastian. The attack was made across the bay there at low tide, and the troops had to wade sometimes up to their waists in water. Incidentally I may say that the "folorn hope" of the storming party was commanded by a man who became very famous afterwards, who was then only a youngster, Sir Colin Campbell, afterwards Lord Clyde. The attack took place and we made some progress, but the French had fortified those breaches very strongly. There was a chevaux de frise and all sorts of devices, and in rear of these there were new French entrenchments strongly manned. The assaulting columns found, when they got to the top of the breach, that they could not get in, and so they were checked on the breach among the ruins of the walls. They were too brave to retire and it was impossible to go on, and so the assault was hung up, and it was reported that our troops were absolutely at a standstill. Alexander Dickson then took what was a very grave responsibility upon himself. He ordered all the siege and shore batteries to open fire on the French defences over the storming party who were lying down on the slopes of the breaches. That means that the shot and shell were passing only a few feet over their heads, Dickson took a great responsibility in ordering this but he did it, and it is to the credit of our gunners that they carried out their task so coolly and accurately, for you must remember that the "error of the gun" was far greater then than now. The batteries kept up a heavy fire for an hour and then ceased fire, and the order was given to the storming parties to push on again. They found that the French had been driven from their defences and that the entrenchments had been battered down. They poured into the town and the citadel surrendered. You can see how valuable was the work of the artillery on that occasion.

In that same year, 1813, Napoleon suffered a very heavy defeat in the centre of Europe. After his retreat from Russia he initiated another very large campaign which ended in the Battle of Leipzic. Leipzic is called the "Battle of Nations", because against the French there were arrayed Prussians, Russians, Austrians and Swedes. We had a British Contingent which was sent to help the Swedes and they were acting then in Schleswig-Holstein, and they had a battle against the French there but only one British unit was with the Swedes at Leipzic. That was the Rocket troop of the Horse Artillery now represented by 'O' Battery. They did very good work in that battle of Leipzic. Their commanding officer Captain Bogue was killed there, so that we can say we had our share in the battle of Nations and the Royal Regiment had the honour of representing the British army.

Then we come to the final crushing victory of the whole campaign at Waterloo. You all know the general details of Waterloo, how the British held the ridge and the many fruitless attacks Napoleon made, how well the French cavalry advanced, how the British infantry formed into squares and beat them off, but you must always remember that Wellington's army at Waterloo was the most scratch pack he ever commanded. They were made up of all sorts of nationalities; he had Belgians, Dutch, Brunswickers, Hanoverians, Nassauers and all sorts of contingents besides his English troops.

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If you ever read Mercer's Diary of the Waterloo Campaign, you will learn of a very fine episode which ought to be known by every gunner. Mercer was ordered to take post with his guns like the rest of our artillery on the slope of the ridge, in front of the line of squares and Wellington had given a strict order that when the French cavalry advanced the guns were to fire to the last minute, and then the gunners were to leave their guns, run for shelter to the squares of infantry behind them, and either lie down underneath the bayonets or go inside the squares. It so happened that behind Mercer's troop (now 'G' Battery, R.H.A.) there were two squares of Brunswick or Nassau infantry—anyhow they were not British. A lot of those foreign contingents had been under Napoleon, they had only been recently liberated from Napoleon's dominion and they knew and had a very wholesome respect for the French cavalry, and when Mercer looked round to those Nassau or Brunswick troops, he saw they were very shaky, that they were looking round to the rear and did not like the thing a bit, so Mercer thought to himself "If my men run back from their guns to those squares these Brunswickers will take it as a signal to retreat and they will go at once and there will be a hole in our line". So Mercer took on himself to disobey Wellington's strict order and he ordered his gunners to stick to their guns and determined to drive off the French cavalry with his fire alone. You will learn, if you read the diary, how the French cavalry came on in great masses, very slowly. All those charges at Waterloo were made at a trot. The ground was very heavy after rain at Waterloo. They came up the hill in close formation. Mercer ordered his men to double shot their guns; that is, they were first to put in a charge of grape, and then on the top of that a round shot, and he waited until the French cavalry was quite close, and then fired and reloaded as quickly as possible. The carnage was something enormous, great lanes were cut through the French horsemen, and this happened not only once, but half a dozen times or more. There were I think eight charges repulsed by Mercer's guns and the next day you could tell where Mercer had been in action by the enormous piles of dead horses and men in front of his battery position.

There is another little episode he relates which is a very good instance of coolness in action and setting a good example to your men which I must tell you. Between the cavalry charges the French sent up their light cavalry skirmishers with carbines to pick off the gunners and kill the horses. In those days the teams remained formed up behind the guns. Mercer's position was on the road that ran along our ridge, with a little bank in front of his guns which saved them somewhat from artillery fire. When these French cavalry skirmishers came hovering round they killed several of his men and horses and he thought he would encourage his gunners a bit, so he did a very plucky thing. He got on his horse and jumped him on top of the bank in front of the battery and walked him up and down encouraging his men while these fellows were coming on. Mercer relates how one of them rode up to within 40 or 50 yards and he saw him take a deliberate aim at him with his carbine. He shook his fist at him and called him all manner of names, and then bang went the carbine, he heard the bullet whistling past his ear and it killed

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one of his drivers behind him. That was a very fine example to set to his men and an instance of great courage and coolness on Mercer's part. The heroes of that campaign were all very famous men; Ross, who commanded "A" Troop right through the Peninsular up to Waterloo. He was the first gunner to be made a Field Marshal. Then there were other famous men like Frazer, Wood and Cleeve. Norman Ramsey was killed at Waterloo commanding another Troop (now 'H' Battery).

After the great war there were certain reforms made in the Regiment which soon ceased to be exclusively under the Master General of the Ordnance, and the year 1833 marks a landmark in our career. In this year it was settled that we should not put any battle honours on our appointments, and that individual units should forego any battle honours, but that the word "*Ubique*", which is our Motto now, should stand for every campaign in which R.A. has been engaged because it means that the artillery have served "everywhere". Teach your men the meaning of the word. "*Quo Fas et Gloria ducunt*" was not so happy in its way, because it was borne by another the 97th Infantry Regiment, before we got it, but since 1833 we have not put any battle honours on our appointments or anything else. When the artillery of the East Indian Company's Army was included in the Royal Artillery after the mutiny they agreed also to forego the recording of their battle honours in the same way and "Ubique" includes their former deeds as well.

I must mention one famous name before I leave the Waterloo period, and that is Shrapnel. Of course you know what shrapnel means now, but it was the invention of a British gunner, Colonel Shrapnel, and it was adopted at once by all foreign nations. The idea was to have a small bursting charge just sufficient to open the shell which was filled with bullets, and then the bullets would spread over the country with their own velocity.

Let me here say a few words about uniform. The first regular uniforms worn by our artillery were of blue turned up with orange, in Charles II'nds time after the Restoration. The orange facings soon gave place to red, and ever since that day the colours of the British Artillery uniform have been blue and red, with the addition in later days of trimmings of yellow braid for full dress.

Our regimental plumage became most gorgeous and most unworkmanlike during the long peace after Waterloo in the days of George IV and William IV. Top heavy shakoes, huge plumes, all the military finery of epaulettes, tassels, gold lace galore, and ornamental equipment of every sort made our gunners a wonderful sight on ceremonial parades. A set of interesting coloured lithograph plates of regimental uniforms by Campion, who was drawing master at the R.M.A. shortly before the Crimean war, show us that the Trumpéters of the Regiment (with the exception of the Horse Artillery) were distinguished at that time by wearing red coats.

Khaki was adopted for the colour of service dress in India, during and after the Mutiny, but was not introduced into the Home Army till the eve of the South African war of 1899. It would be useful if a "Supplement" to Macdonald's "History of the dress of the Regiment" could be published giving the old uniforms of the Bengal,

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Bombay, and Madras Artilleries. They are now incorporated in the Royal Regiment and the history of the evolution of their dress and equipment is of equal value and interest.

We had a long peace from Waterloo up to the Crimea and during that time artillery made considerable strides. There were lots of new inventions, and a very great name in artillery history, especially in connection with ammunition, was Colonel Boxer. Boxer's name was a great name when I first joined the Service. There was the Boxer wooden time fuze, and he invented all sorts of improvements in ammunition which were of great use to our artillery in the Crimea. I am going to give you one instance of the great value of gun power as my "Artillery Episode" for the Crimean War. You know how splendid the work of our heavy guns has been out at the front in this war and the value of weight of metal in counter battery work. One of the most critical battles of the Crimea was practically won by the timely intervention of two British heavy guns and that was the Battle of Inkerman. You know the battle formed the right of the investing line during the siege of Sebastopol. We did not surround Sebastopol during the siege; we were on two sides of it, and the other side of Sebastopol was an arm of the sea which formed a harbour and the far side of the harbour was quite clear. *There* was the town of Sebastopol and *there* was the harbour, and the French were *here* on our left and we were *here* (making a sketch). We were on the high ground *here* and at *this* end a lot of ravines came up from the harbour side and the heights ran back like *that* to the town of Balaclava down *here*. Owing to our not investing the town all round, the Russians were able to get any amount of reinforcements from the north side; they got a large army across during October and on the 5th November they made a sortie from the town and attempted to surprise the right of the British line up these ravines. It was a very foggy morning. There was a hill *here* called Signal Hill on which they set their artillery which rather dominated a part of our plateau and they had 40 guns there. Meanwhile the infantry crept up these ravines and surprised our picquets in the fog and it was a hand to hand business. Inkerman is always known as the "soldier's battle" because there was very little possibility of giving orders and it was every man for himself. They fought like demons and only just managed to hold their own, but they were pressed back a good deal until towards midday our artillery commander who was Collingwood Dickson (Collingwood Dickson was a son of Alexander Dickson whom I told you about before, and I will talk to you about the recurrence of famous names, and families, etc. in the artillery presently) remembered that there were two 18-pr. heavy guns that he had not put into the siege batteries, in the camp and he sent for these. They were brought up as quickly as possible with horses, men, and drag ropes. I daresay General Arbuthnot can tell you much more about the battle operations than I can as he was there but anyhow the 2 eighteen pounders were got up to the ridge, and from the very beginning those eighteen pounders began to make themselves felt against the Russian artillery. Eventually they knocked out all the Russian guns and practically silenced the artillery fire and our troops were able to hold their own until reinforcements came

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up in the evening, a French Division under General Bosquet, who took the Russians in flank and helped us to win the battle. Unless we had had those two heavy guns at that critical moment things might have been very serious. There was a very fine old artilleryman killed in that battle called General Strangways.

The last episode I shall tell you of was in the Indian Mutiny. You must know that there are many famous units which have descended from our Indian Artillery which were under the East India Company until after the Indian Mutiny and the Indian Artillery had a very high name, but I am going to give you an instance this time of the personal gallantry of individuals, not of units. This was the heroism of two officers and a few artillery sergeants and conductors of the Indian Ordnance in the Magazine at Delhi in May 1857. On the outbreak of the Mutiny the mutinous regiments collected at Delhi because there was an old pensioner who was a descendant of the Moguls in India whom they wanted to make King of India and put on the throne, so the Indian regiments massacred the Europeans and they all marched on Delhi from Meerut and elsewhere. They were collected in Delhi and there was a Magazine. This magazine had a large store of guns and ammunition. It was also a great place for repairing guns and all ordnance work in fact, and it was built into a bastion inside the ramparts like *that* (making a sketch). The bastion was walled off and there was a postern gateway there with ramps running up to the walls on each side and all round the enclosure were sheds in which were the guns and carriages and workshops. Here there was a sally port which led towards the river bank. In the centre of the courtyard there was a magazine which was full of combustibles and artillery stores of every description. The officer in command of the magazine was Lieutenant Willoughby and he had a young subaltern Lieutenant Forrest with him and there were about seven European conductors and sergeants and a large number of native artificers. The mutinous regiments, several thousand strong, came down and called on Willoughby to surrender. He refused. They said they would give him an hour to think about it and if he did not surrender then they would take the place by escalade and capture him and put him to death. He still refused, of course, and set to work to make his arrangements. What he did was to get out several guns and howitzers and he put them all round here commanding the entrances and ramparts and put ammunition alongside them. Then one of the conductors, an Irishman of the name of Scully, proposed to Willoughby that when things came to a crisis, as a last resort he should blow up the magazine. Scully claimed the honour of firing the magazine himself although he knew he would be blown up with it; so a train was laid *here* which ended by a little tree or bush and Scully stood there with his portfire ready for the supreme moment. The signal agreed on by Willoughby was that when he lifted his hat and waved it Scully was to fire the magazine and that all who survived should take their chance of escaping by this little sally port towards the river. Well, the mutineers came on and as soon as the scaling ladders were put against the wall and dropped over to the other side the whole of the native Establishment inside the Arsenal deserted—bolted—and at

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the same time the mutineers began lining the wall. Presently they burst open the gate. The nine Europeans fired one gun after another and reloaded them as fast as they could against all these men who were up on the parapets *here*, on the roofs of the buildings, and also trying to get into the gate *there*. They held their own and brought their guns to bear on these thousands of mutineers (I think there were 6000 or 7000 of them) and created the greatest havoc among them until at last one after the other of the brave artillerymen dropped wounded or killed, and Willoughby saw that the time was come and he lifted his hat. Scully fired the magazine, and those who were unwounded, which was only three or four, rushed for the gate. Only two got away; one was Buckley and the other Willoughby. When they got away to the river they had to try to make their way to Meerut where the nearest European garrison was, many miles away, and to get food and water as best they could. Willoughby could not stand the hunger and thirst and he went into a native village to try to get food and water and he was killed by the inhabitants. Buckley got away and survived. That was one of the finest exhibitions of heroism that has ever been done in the Regiment, the defence of the magazine at Delhi.

After the Mutiny, in 1859 the Indian Artillery was amalgamated with the Royal Regiment. There are many famous names in the East Indian Company's Artillery, one of which is Sir William Pollock. You know the Pollock Medal given at the R.M.A. is named after him. He led the avenging army into Afghanistan after the massacre in 1842. Then there are several other famous names Lord Roberts, the greatest of all, Tombs, Vincent, Eyre, Christie, Bunny and Olpherts, who was always called "Hellfire Jack" on account of his lurid language, and his wonderful bravery too. On the Bombay side you have the names of Leslie who commanded the 1st Troop Bombay H.A. (now 'N' Battery R.H.A.) which was given the right to wear an Eagle on its appointments for its good work in Afghanistan and Sind between 1838 and 1843. It is still called the 'Eagle' Troop. The Jacobs and Pottingers are also Bombay "Gunner" names. The Pottinger family has been concerned with the Regiment, either the Indian Artillery or the British, for the last four generations and is still represented among us in this war. I could tell you many famous gunner names in the Mutiny days one of them, Cornwallis Maude, a Royal Artilleryman got the VC. at the Relief of Lucknow and commanded Havelock's guns.

After the Mutiny we began to develop rifled artillery. The rifled gun first came in when Armstrong devised the system of grooved rifling, which lasted for a time but there were difficulties with ammunition and one thing and another, and we went back to muzzle loading artillery for a period, and when I left the R.M.A. in 1879 they were still using the muzzle loading guns. I joined a Battery of the Field Artillery (then B/1st Bde. now the 2nd Field Battery—a "Minden" unit) which had 16 pounder muzzle loaders in those days. Developments came very quickly and one of the most important was the substitution of the present nitro-compounds for gunpowder. Up till then we had used gunpowder entirely, but nitro-glycerine was invented and gun-cotton and all the new things until we get cordite.

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In ammunition there is no name more famous than the name of Andrew Noble to whom we owe many recent scientific developments of gunnery appliances, ordnance, and ammunition. We must not forget either the advances in ordnance which we owe to the great gun manufacturing firms of Armstrong, Whitworth and Vickers-Maxim. Other inventors were Nolan, and Watkins who originated our range finders. Scott, who invented Scott's sights, and many others.

I have mentioned one or two instances of family names being repeated in the Regiment through different generations. I told you of Congreve. His son invented the Congreve War-rocket and made a lot of improvements in artillery. Alexander Dickson was succeeded by Collingwood Dickson, and if you look through Kane's List, the nominal roll of officers of the Regiment since its earliest days, you will see the family regimental names repeating themselves over and over again. Mercer, Cleeve, Radcliffe, Hay, Ravenhill, Adye, Tyler, Nairne, Arbuthnot and a host of others—many of them often repeated—so that one feels a special interest in our well-known Regimental names.

I will not go much more into the history of incidents of recent times because you know as much as I do about most of them, but I will just mention South Africa where several V.C's were won in saving the guns, or trying to do so at Colenso, and the splendid stand of "Q" Battery, R.H.A. at Sanna's Post under Major Phipps-Hornby, as he was then, when the Battery got 4 Crosses, one for Officers, one for Sergeants, and one each for Gunners and Drivers. Then there was the very fine episode in Afghanistan in 1880, of E/B R.H.A. during the retreat from Maiwand. Every one remembers the saving of the guns by Blackwood's Battery; Blackwood was killed there and Slade commanded the battery in the retreat, a very fine piece of work, when Sergt. Mullane gained the V.C.

Then you come to later times. In this war I need not tell you what the gunners have done all through. Capt. Reynold's V.C., gained trying to save the guns at Le Cateau. L Battery at Nery where they were almost annihilated and yet fought and knocked out a very much larger force of German artillery than themselves. All these incidents and the work of all our artillery throughout the war show that the gunners of to-day are not a whit inferior to the gunners of the old times and that the same spirit still animates the Regiment. You ought to learn up and tell your men these things because there is nothing like keeping up esprit de corps, and the more you can learn from the regimental histories and records and the more you can tell your men about them the better for all ranks.

It is not only in war that the Regiment has been famous. We have had men who have made their names in all sorts of careers. Take diplomacy or administration, there was Lord Cromer who died only a little over a year ago. In 1916 we celebrated the Bicentenary of the Regiment. 1716 was its birth as the Royal Regiment and in 1916 it was 200 years old. Lord Cromer wrote the most delightful letter, saying how proud he was to have served in the Royal Artillery, as he always remembered he was a gunner from his original connection with the Regiment; and he was a gunner to his life's end

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although he had left the Regiment and taken up other pursuits. Then there was Sir Henry Lawrence who was killed at the Residency at Lucknow in 1857. He was an Indian gunner. There was another very famous ex-gunner Diplomatist called Law who did a lot of valuable administrative work in the Eastern Mediterranean. He is buried at Athens where he was a Diplomat. Gunners have been famous in all sorts of other walks of life. Sir Edward Sabine was President of the Royal Society; he was a great Astronomer who went on several exploring expeditions to the Arctic Regions. Hamley, and Kaye made their name as writers on Military History and strategy. De Lesseps acknowledged his indebtedness to Col. Chesney of the R.A. for the idea of the Suez Canal. In some of the humbler ranks we have had some famous men, including Gunner William Sturgeon who enlisted in the Royal Artillery from being a cobbler. He was a man of a very inventive and inquisitive turn of mind and he took up electricity. Now he could not get the works that he wanted in order to study electricity and mathematics, so he taught himself French, German and Italian in order to be able to study foreign works on the subject. He served his full 15 years as a gunner in the regiment, refusing promotion, he would not take a stripe. When he left the regiment he took up the study of electricity and made some very fine researches which were very valuable at that particular period when electricity was in its infancy. That was a gunner. I daresay very few of you know that the highest mountain in the world is named after a gunner, Mount Everest. Colonel Everest was on the Survey of India and he named the mountain there. Then we have towns named after gunners in India; Abbottabad is named after Colonel Abbott, a Bengal Gunner who was one of Sir Henry Lawrence's subordinates. On the Bombay side there are several famous Bombay Gunners. I told you of Eldred Pottinger, the defender of Herat. Jacobabad is named after General Jacob a Bombay gunner. So that we have held our own in many spheres of life besides in war, and it is good, as I said before, to learn all about the gunners in every sort of career. It must be a source of pride to every gunner to feel that he belongs to a great and famous family. Of course of late years the Garrison Artillery has been separated from the Horse and Field, but when I joined it was not so; we were all one large Regiment and I served in all three branches horse, field and garrison. Even still the spirit exists of that family connection amongst all sorts of gunners, and one great advantage which a gunner has over an infantryman is that wherever he goes in this world, wherever there is a Gunner Mess, there he is at home. I have felt the advantage of that many a time when I have been travelling about India, wherever there was a Gunner Mess I went there because I knew that I should be welcomed and find myself amongst friends. So always remember to help any brother gunner of whatever rank who comes along, wherever you may be. Always look on the Regiment as one large family including both officers and men. You officers must make friends of your N.C.O's and men. Encourage them and teach them in every possible way. I always tell my men that R.F.A. means "Ready for anything". Above all put that great spirit of comradeship and devotion to the traditions of the gunners

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into them and always remember the glorious History of the Regiment you belong to. (Loud and continued applause).

THE CHAIRMAN: Ladies and Gentlemen, I hope that this interesting lecture we have had from Colonel Hobday will incite those who have not had their interests directed to these matters before, to make some researches, both from the antiquarian point and the historical point of view. There is a very fine collection for any officer who has time to study every now and then at the Rotunda which belongs of course to this Institution—a very fine collection indeed—and there he will find all sorts of arms and implements and historical references touching on the points that Colonel Hobday has mentioned. The carriage which Kohler invented at Gibraltar for depression firing is reproduced in Sir Joshua Reynold's picture of General Elliott or as he afterwards became Lord Heathfield, in the National Gallery, and he is represented there with the Key, supposed to be holding the key of the Rock, in the palm of his hand.

The lecturer mentioned about the Rocket Troop being the only Unit of the British Army represented at the Battle of Leipzic. That was an allusion you do not often come across, rockets on the field, because the rocket was so very uncertain a projectile that it was not a success. Nevertheless now and then I daresay uses were found for it and amongst other things it was supposed to frighten horses which it did most certainly. When I was a cadet and afterwards we used to be taught how rockets were made and, if we had the boldness to try to fire them. There was an examination being held once for young officers on whom these uncertainties of this projectile had been very much impressed and one of them was asked the question "Give a description of a war rocket" or "What is a war rocket?", and his answer was this "A rocket is a thing which if you put it on the ground and light it at the reverse end, it will turn round and go in the opposite direction". Any one who knows anything about a rocket will know that that is not at all a bad description of it. Now as regards the questions of badges when we use the one motto "Ubique" and sum up everything in that, I think it must have come about from some very natural feeling at the time; there were several units in the Regiment who had very distinguished badges, and of course they did not conceal them at all. I daresay they made the most of them, and there were certain others who felt that they deserved them, who did not have any at all. Consequently it led to this feeling coming up that they should all be swept away and that they should go in for nothing at all of that kind. Now that feeling comes up in the Service every now and then at all times, it is only human nature. I see in the paper to-day that the new Air Service is to do away with tabs—there are so many colored tabs in the Service now that this new Service is going to have no distinction at all. How long they will be able to get on without them I do not know, but you will find that it will probably come into the Service before long. At present, however, they are not having any of the old or already established distinctions.

I hope that anybody who would like to ask the lecturer any questions will do so, because I am quite sure that if he only had time he has an immense amount of information to give, and perhaps there

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is something that some particular officer here to-night might like to ask. The information is ready if he likes to ask for it. (Loud applause).

GENL. ARBUTHNOT. Ladies and Gentlemen, Colonel Hobday said that I could tell you more about the 18-pounders at Inkerman than he could. I happened to fire the first shot, and it happened in this way. Our advance picket was strengthened by two guns in the day time. That morning I was just going on picket when I heard the firing at the picket where I was going to, by which I knew that the Russians were attacking us. I was in the Second Division on the extreme right of the English line and I knew it was no use my going on to the picket, because probably I would only have lost my Mess and done no good; so I came back to the position assigned for the artillery in case the Russians attacked the English army on the right flank. From that position I fired the first shot. When the two 18-pounders came up, my battery was on the right and the other battery was on the left, and the two 18-pounders were right in the middle of the batteries. We were frightfully cut up because the Russians concentrated all their fire on the two 18-pounders. The two 18-pounders had the greatest effect on the result of that battle.

Colonel Hobday has emphasized the fact that you should all direct your minds to what gunners have done in former days, and I can only say that when Major Leslie gave a lecture here some few years ago on the best way of maintaining the traditions of the Royal Artillery he took exactly the same line. You are quite right that the traditions of the Royal Artillery will never die out, and all I have got to say is that you young officers who are now joining have only got to follow in the footsteps of those who have gone before you, and the best traditions of the Royal Artillery will always be maintained. (Loud applause). There is one point which I think Colonel Hobday did not emphasize enough, and that was as to the formation of the Field Batteries. At the time of the Crimean War there were no Field Batteries. The whole of the Regiment as he said was formed in companies and the company might be a Garrison Company one day and a Field Battery the next. I had just joined the Regiment then and the Company I was attached to was under the orders of General Lawrence, a Garrison Commander. When the war ended we were turned into a Field Battery and I do not think we failed in our duty, although the drivers and gunners were all indiscriminate; a man enlisted as a driver and gunner, and there was no distinction between them then, and all the Field Batteries in the Crimea had been Garrison Companies before they started, but I think we did our work very well in spite of that.

Gentlemen, I am a gunner to my finger tips and I am very proud of the Regiment to which I belong. (Loud and continued applause).

THE CHAIRMAN: I will ask you, Ladies and Gentlemen, to accord a cordial vote of thanks to Colonel Hobday for his very interesting and instructive lecture. (Loud and continued applause).

COL. HOBDAY. Generals Cleeve and Arbuthnot, Ladies and Gentlemen, I am very proud of the way in which you have received the little historical lecture I have been able to give you. It has been

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a labor of love to me and as I have told you the sources where I found my information you can find more for yourselves. I will just add one thing and that is that breech-loading artillery is not a thing of the present day as you may think, because we had breech-loaders in the days of Queen Elizabeth. There is one now in the Rotunda, the "Serpentine" as they called it in those days, which is on the Armstrong breech loading principle, with a removable breech block and a screw behind it exactly on the same plan. Also I might mention to those who have not realized the fact, that when I mentioned heavy guns at Inkerman, and General Arbuthnot spoke of 18-pounders, you might confuse them with the 18-pounders of to-day which are light field artillery, but in those days the 18-pounder was a siege gun and it was considered a very heavy shot. I thank you again for the way in which you have received my lecture. (Loud and continued applause).

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EPISODE.

An old regular Brigade on 21st March, 1918.

"A" Brigade consisted of 4 batteries "W" "X" "Y" and "Z", of which "W" was detached to another Group.

Each battery was finding (a) one or two anti-tank guns (b) a forward gun or section (c) a main position.

The anti-tank guns fought until the guns were destroyed or the ammunition ran out, after which what remained of their detachments fought with their rifles. In some cases two, in some cases one, in some cases none, of the detachments got back to their batteries. No gun fell into the enemy's hands fit to be fired.

"W" Battery's forward gun fought till smashed up. The guns at its main position were knocked out one by one, one gun remaining long after the others firing direct over the sights out in the open. When this gun also was knocked out, the battery continued to resist with the greatest possible effect with its Lewis gun and two remaining rifles.

"X" Battery fought its forward guns long after the infantry had retired past them. By the great gallantry of the officers, N.C.O's, gunners, and drivers concerned, two guns were successfully pulled out under heavy rifle and machine gun fire at close range. The battery as a whole withdrew after dark with the loss of only one gun smashed to pieces early in the day.

"Y" Battery's forward section was fought until not a single round was left. One gun was knocked out early with its detachment. The other fired no less than 1700 rounds in 20 hours. At the end it was out in the open engaging enemy infantry masses at decisive range. It was impossible to pull it out, and the subaltern destroyed it effectively before he withdrew the remnants of his two detachments. The main portion of the battery was also out in the open engaging the German infantry over open sights. The battery got away safely after dark except its two forward guns.

"Z" was a howitzer battery. Its forward section was firing unceasingly until the enemy got into it from a flank. Not a man returned. The main position of the battery had to be withdrawn a few hundred yards for reasons of ammunition supply. Its guns were out of their pits engaging advancing infantry and the battery was under machine gun fire from a few hundred yards distance, when the teams arrived. The guns were successfully limbered up and withdrawn, not a single team coming out with all its three drivers up, and nearly every horse being hit. From the new position the battery opened fire with good results until withdrawn after dark. Every one of its nine officers became a casualty, and the battery was commanded by a corporal for some hours.

It is thought that this record is well up to the best traditions of the Royal Regiment, but it is not contended that the performance was unique, for accounts from all along the line tell the same tale of courage and faith unto death.

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INDOOR GUNNERY.

By Major B. J. T. Ford, R.F.A. (T).

THE dark cold days of winter and the variation of climatic conditions, emphasise with particular force the advantages to be obtained in rapid training, by the provision of abundant indoor apparatus for the instruction of Gunners in their manifold and important duties.

A biting wind, and sodden ground, with rain, or snow as accompaniment, form a by no means favourable setting for instruction, in Laying, or in Battery Gun Drill, and discomfort has proved the most effective deterrent to efficient training by its effect upon the mind and body of teacher and pupil alike.

Experience has proved that small classes conducted under comfortable conditions can make more rapid progress, than a large class under any conditions, because it is easier in a small class to give individual attention to the pupils, and if conditions are favourable more concentrated attention and more intensive instruction are alike possible.

Gunnery Indoors sounds an impossibility, and yet by the use of model guns it can be accomplished with ease, and most successfully.

A photograph (No. 1) is appended showing a Model Gun, one of a Battery of four, which are in actual daily use in a training Battery.

These guns have been made entirely in a Battery Workshop, without the aid of any machinery or even of suitable tools.

A Battery of four or six of these Guns can be used in one Hut according to the size of the Hut and it is surprising how effective and realistic the work of instruction can be made.

Loading. The gun can be loaded, in the usual manner with a suitable dummy shell made in two parts, one representing the shell, the other the cartridge case.

An extractor forming part of the breech mechanism ejects the cartridge case on opening the breech, in the same manner as in the 18-pr. gun.

Laying. The gun can be elevated and depressed at will, and is provided with an axial traverse enabling deflection to be obtained without use of the traversing handspike or moving the trail.

The laying may be done with either No. 1 or No. 7 Dial Sight, and the Sight Clinometer finds its place and can be used as on the 18-pr. gun.

A Rocking Bar Sight, and Model Telescope are also fitted for direct laying.

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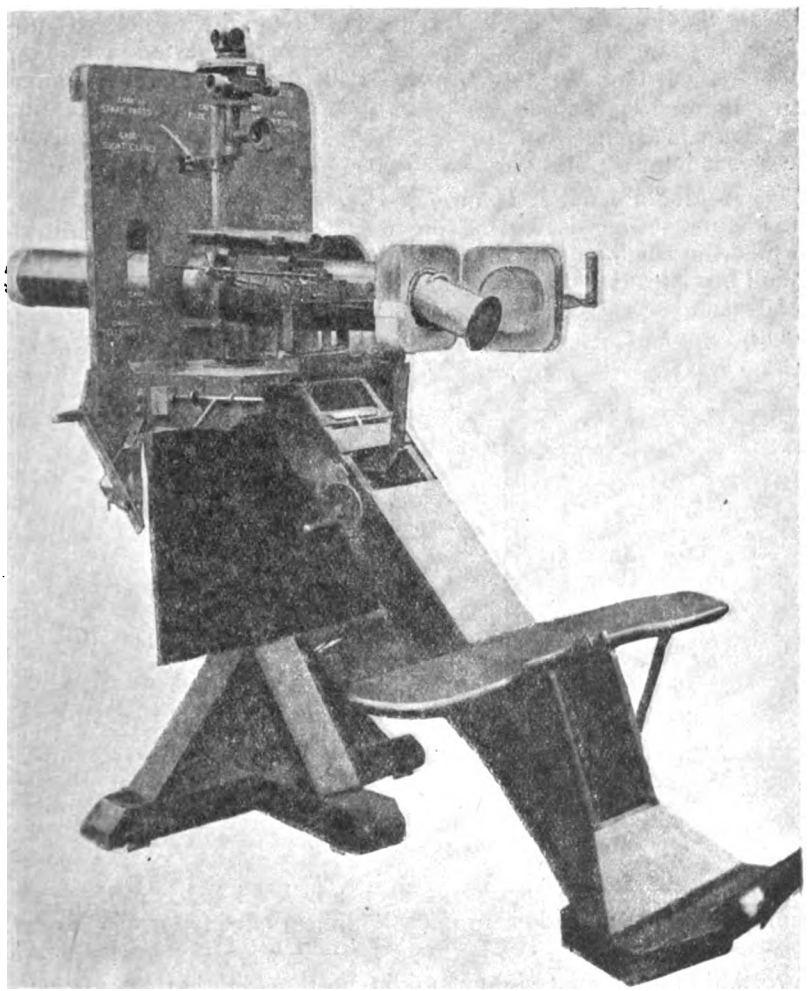
The range is put on by means of a revolving range drum, which will be found in the usual place.

The trail which is fitted with seats for Nos. 2 and 3 is operated by means of a traversing handspike, enabling the gun to be traversed in the ordinary way by the No. 1.

A shield on which the No. 1 Dial Sight can be placed is provided and upon it there are indicated the various positions of the stores



No. 1.

carried on the gun shield when prepared for action. A hinged extension is added which can be raised or lowered as required.

A firing lever working on a spring buffer, enables the action of

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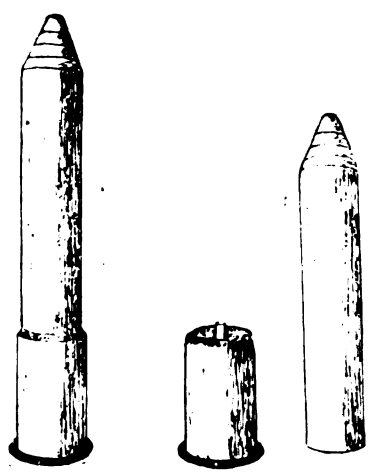
firing the gun to be correctly taught. A quick release brake, hand brake and clamps are fitted in their relative positions so that their uses may be demonstrated and practised.

By means of these guns, laying can be taught in a hut more quickly than on the Gun Park, whilst the quietness and comfort of indoor instruction enable a black board to be brought into use and specialised laying taught, difficulties being explained and principles demonstrated by means of sketches on the blackboard.

Night Laying. Night Laying can be taught in the hut irrespective of weather conditions and by screening the windows this most necessary part of a Gunners work can be taught in the daytime also.

Battery Gun Drill can be carried on with ease, and combined schemes in connection with a Miniature Range in the Hut are also of great interest, and very instructive.

A Model Limber is provided, containing 18-pr. drill shell, so that fuze setting is carried on at gun drill with these drill shell, whilst the small special shells are actually loaded into the gun. The shell becomes detached from the cartridge case by the act of loading and each successive shell pushes the previous one out at the muzzle of the gun.



These guns can also be used on any level space in the open in fine weather, though their primary and most effective use is for indoor instruction.

Although at first sight it might be thought that these guns are only *Toys*, experience of their utility has clearly proved—

1. That they are invaluable for indoor training.

2. That most of the instruction necessary in gun drill on the 18-pr. Q.F. can be given upon these guns.

3. That their mobility and lightness enable laying to be taught with the minimum of labour and time.

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In the Battery alluded to, hundreds of men have been rapidly and successfully taught the rudiments and principles of their profession on these Model Guns leaving only the finishing touches to be put to their gunnery on the 18-pr. guns when available.

The men themselves as well as their Instructors are most appreciative of the advantages of this method of training, and the rapidity with which they pick up their drill and laying shows that model guns can effectively take the place of the 'real thing' under certain conditions when necessary.

When equipment is difficult to obtain and every serviceable gun is required for actual use in action, the claim of the Model Gun for instructional work appeals with greatest force: and as in these days of intensive training climatic difficulties have to be met and overcome in the rush for skilled gunners, the demand for indoor instruction must be answered to the full if the men are to be trained and ready when the summons comes to send them overseas.

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PRUSSIA'S PART IN THE SEVEN YEARS' WAR.

A Lecture delivered at the Royal Artillery Institution, Thursday, 21st March, 1918.

By Brig.-Genl. F. G. Stone, C.M.G., *psc.*, R.A.

Major-Genl. W. F. Cleeve, C.B., R.A., Comdt. R.M.A. in the Chair.

THE CHAIRMAN: Ladies and Gentlemen: General Stone is going to give us a Lecture on "Prussia's Part in the Seven Years' War". He has delivered Lectures to us on other subjects and I will ask him, if he will not mind the small audience, to begin his Lecture.

GENERAL STONE: General Cleeve, Ladies and Gentlemen: With a debate such as took place in the House of Lords the other day which was taken part in by Lord Lansdowne, Lord Loreburn, Lord Parmoor and others, it behoves us and everybody who has the welfare of this nation at heart and the welfare of civilisation to realise what a peace by agreement with Germany would mean. It would mean the defeat of this country and there is no getting away from it. We have agents in this country, some of them paid cash over the counter for their services some of the Germans writing to the Press under English names, and we read these writings and we believe they are written by Englishmen. But they are written by Germans. There is no means of knowing. Up to the other day I saw over and over again notices in the "*Times*" of Germans changing their names to English names. God knows why it is allowed, but it is allowed. There can be no question about it that we have the friends of Germany, and therefore the enemies of this country, at both ends of the social fabric; we have got them at the top of the tree in cosmopolitan finance and we have got them at the bottom in Bolshevik Socialism. The most dangerous enemies of this country, the most dangerous enemies of all, are the dupes of German agents who believe that they are sincere and do not know that they are doing Germany's dirty work. There are thousands of them in this country at the present moment who are preaching sedition, preaching pessimism, preaching all kinds of things—anything except the preservation of the British Empire, and of those thousands at least half I firmly believe are quite unconscious that they are the Agents of

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Germany, and therefore they are the more dangerous. That is why I appeal to you. I feel quite sure in addressing an audience such as this is that everybody is in agreement with me already. But it behoves every individual of us to spread our influence wherever we can in our own environment to stop any peace talk and have none of this rotten pessimism and none of this making peace by agreement, which is playing Germany's game. Unless we stop that, unless we refute all the absurd arguments that are brought to bear by reasoned arguments which are perfectly easy to bring to bear upon the subject, we shall not be doing our little best in our own sphere to save the Empire. I have drawn my history in this Lecture from Carlyle's "Frederick the Great", "The Evolution of Prussia" by Marriott and Robinson (which is an extraordinarily interesting little book and is a very concise summary of Prussia from earliest dates up to the beginning of this war), and the Cambridge Modern History, Vol. VI.

Lieutenant General Baron von Freytag-Loringhoven, in his "Deductions from the World War", begins with the following remark:—"The grouping of the Powers at the beginning and still more during the course of the World War has been extremely unfavourable to the Central Powers. We must go back to the desperate struggle of Frederick the Great in the Seven Years' War, to find anything comparable to it."

A brief analysis of the political, military, and economic factors which contributed towards the evolution of Prussia during this period, and embracing the two Silesian campaigns of Frederick the Great, immediately prior to that period, as well as the years of reconstruction which succeeded the war, will perhaps do more than anything else to help us to understand the German point of view to-day, the German ideals of to-morrow, and the strength of purpose which the German Nation may be expected to show in enduring to the end. I venture to think that such a study will be of more profit to us, than the perusal of accounts in the daily press of food shortage, unrest, and strikes in Germany to-day, which are allowed to find their way into our newspapers in such form and at such times as the German High Command think suitable, from the point of view of influencing public opinion over here in the desired direction.

In 1740 Frederick inherited a well filled treasury, a large and well disciplined army, and an autocracy which was undisputed and indisputable. He had been brought up in a hard and unsympathetic school, which had converted an eager, high spirited, sensitive boy, with an inherent love for the beautiful and refined, into a brilliant intellectual cynic to whom love, loyalty, generosity, charity, and chivalrous ideals, were the plaything of the mocking gods; and human virtue, like human vices were simply counters in the relentless game of destiny. As Crown Prince he had held out eager hands to the fire of life and found no warmth, but a hard clear light and that only to be seen through tears.

He had married in obedience to the will of his detested father, but his Queen had no place in his home, his pleasure, his duty, or his ambition: he never shared with her one thought, one aspiration, one hope or fear. In the agony of the Seven Years' War, when ruin stared him in the face, he neither sought nor expected comfort, still

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less strength for his titanic struggle, in a woman's devotion. Of charity, generosity, faith in the humanity that joy and sorrow can enrich, he felt no need: his heart was withered up. Friendship as a bond of human souls was unnecessary,—a temptation to weakness. Duty, which became his watch-word, was work without love or pity, the irresistible demand of a universal Reason and not the inspiration of an Almighty Father.

He was a brain, disciplined in the dictates and service of Reason. Policy and the State were to be governed and interpreted in the clear light of that reason, which alone made the world and human conduct intelligible and tolerable. In the temple of Reason the King was the high priest, whose duty was to purge it of the idols of the tribe, the market place, and the palace.

Power was only justifiable if used to promote rational well-being, to transmute into gold the leaden metal of humanity, and to drill the human will to realise a rational life. Power must therefore be as unlimited as Reason.

Frederick's enlightened absolutism, of which he became the incarnation in the eyes of an admiring century, was subtly and inextricably blended with the ambition of the Hohenzollern and the pride of the Prussian King. Frederick identified himself completely with Prussia; the power and prosperity of Prussia were at once the end of enlightened reason and the title deeds of rational government. Enlightenment would make Prussia strong: the strength of Prussia would be the triumph of Reason.

Such was the Monarch who in 1740 commenced to sow the seed of Might against Right, which in his own life time made Prussia a great Power in Europe, under the influence of his own indomitable driving power. After his death it almost seemed as if the structure which he erected with such infinite pains, was doomed to crumble away, in the absence of the continued application of the forces which had been focussed in himself, and which failed to find inspiration or direction when he had gone. But the seed which Frederick had sown was not destined to perish, and the temporary sets back which Prussia had subsequently to submit to when her destinies were in less competent hands, only serve to throw into bolder relief the giant strides which she made from 1866 onwards, to the consolidation of the German Empire by the war of 1870-71, and the complete Prussianisation of that Empire as we see it to-day. The difference between the Prussia of Frederick the Great, and the Germany of to-day, is, simply that the spirit of Frederick is no longer a solitary compelling influence, driving less willing spirits to do its bidding by sheer force of unique personality enshrined in autocratic power; but it is reincarnated in thousands and thousands of the German ruling class and breathing in an atmosphere fully charged with the unalterable belief in Germany's great destiny as a World Power. Frederick's rape of Silesia from Maria Theresa, was effected in a manner so thoroughly characteristic of the Prussian spirit which animates the Germany of to-day, that while it serves as a key to the mentality of the Prussian autocrat of the 18th century, it also opens the door to the point of view of the modern Prussian—German Autocracy—a point of view which has certainly been clearly defined

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by many German writers, but which is really very little understood by the great masses of the English people.

Frederick William I had been one of the guarantors of the succession of the Archduchess Maria Theresa; her husband, Francis of Lorraine was to succeed Charles VI as Emperor and continue the imperial crown in the House of Habsburg—Lorraine. The instrument embodying this succession was known as the Pragmatic Sanction.

Charles VI of Austria died on Oct. 20th, 1740. Frederick cast covetous eyes on Silesia, which would be obviously an asset of first rate importance to the Kingdom of Prussia, and Prussia's need was in his eyes ample justification for conquest if diplomatic pressure was found to be of no avail. The idea of being bound by the treaty to which his Father had subscribed, never seems to have occurred to him as a deterring factor, or rather, it occurred, simply to be dismissed.

Reasons of State were independent of and superior to the personal honour of the sovereign. Maria Theresa was in difficulties —her difficulties were Prussia's opportunity. Prussia was ready, and she was not. Ambition, as he confessed later, whispered to a listening ear. He could succeed by a rapid and unexpected blow. How irresistibly this reminds one of Belgium in August 1914! But with a cynical coolness which is difficult to parallel, he informed Vienna that he had the will and the power to take Silesia, and that if they would yield it up, he would secure the imperial crown for Francis, and stand by Maria Theresa and the Pragmatic Sanction against the world; but if this cession of territory was not offered with a good grace, then the enemies of the House of Habsburg would be his friends and allies. This proposal of robbery punctuated by blackmail, was rejected with scorn, and Frederick crossed the border at the head of his army, thus precipitating a European war. The first Silesian war was fought to win Silesia; the second to keep it. Frederick had a clearly defined object. He needed allies, but their object was not his. He had no intention of treating them any better or any worse than he had treated Maria Theresa: they were merely pawns in the game of Prussian aggrandizement. By combined unscrupulous diplomacy and hard fighting, Frederick obtained the cession of Silesia by the Treaty of Berlin, July 28th, 1742, threw over his allies for the third time, and retired from the European war.

Frederick immediately set to work on the assimilation of his newly acquired territory, and the reorganisation of his army, all the time watching carefully the diplomatic and military situation in Europe. Austria at the same time was steadily achieving a position of increasing strength as against France and Bavaria. If Austria succeeded in defeating the Franco-Bavarian coalition, Silesia would be lost. Frederick formed the Union of Frankfort composed of some of the minor German Princes, and renewed his alliance with France in consideration of obtaining a share in the partition of Bohemia. His avowed object was the restoration of the liberty of the German Empire, but he was actually fighting to retain Silesia (Aug. 7th 1744). The war was ended by the Treaty of Dresden (Dec. 25th 1745) which confirmed the Treaty of Berlin and the

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Convention of Hanover. The Prussian treasury was empty, and the army terribly reduced in numbers and efficiency by the strain of this bloody but successful campaign; and peace was more than welcome. Frederick had kept Silesia: he had added 15,000 square miles and 1,250,000 inhabitants to his kingdom; he had immensely increased the industrial and agricultural resources of Prussia and greatly improved her strategic position in relation to Saxony and Austria, and had annexed East Friesland with its growing port of Emden. The eleven years which intervened before the outbreak of the Seven Years' War formed a period of consolidation which saw Frederick at his best: he considered himself "the first servant of the State"; the service of the State was his religion; and truly no State has ever had a more efficient servant, and no religion a more ardent devotee: neither pain or pleasure, neither fatigue or longing for ease, neither church or critic, no praise, no blame, no hope of heaven or fear of hell, could for one instant divert him from his aim or cause him to flinch from the duty which he had set himself to perform—and that aim, that duty, was the aggrandizement of Prussia. Night and day Frederick had before his mind the conduct and conditions of a great war. Prussia was poor, the army absorbed 8,500,000 out of a revenue of 11,000,000 thalers. Prussia must be farmed to produce the maximum amount possible out of every acre and every profitable industry, to provide funds for a formidable army and a reserve of treasure which would enable her to outlast her enemies in a long drawn out war, depending solely on her own resources. The army was Prussia and Prussia was the army, and while Frederick was engaged in perfecting the great military machine, not forgetting his own self instruction as the head of it, he was also employing his time in those strenuous days, in wrestling with problems of diplomacy and administration under self denying conditions which were forging and tempering the cells of the spirit no less than the cells of the brain, not only in his own person, but also, though in a less degree, in the Nation as a whole. The stern economy, relentless labour, and unquestioning self sacrifice of those days, well and truly laid the foundations which enabled Prussia to weather the storm of the Seven Years' War, and to achieve the remarkable recuperation after that exhausting struggle to which I shall draw attention later on.

Frederick's seizure of Silesia had made Maria Theresa his implacable enemy, she had the ablest diplomat of the day in the person of Kaunitz, to assist her in working for the downfall of Prussia by means of an irresistible coalition against that aggressive state. In 1754 a rapprochement was secured between Austria and France, with whom Prussia was already in alliance. War between France and England was impending, and to save Hanover, England concluded with Frederick the convention of Westminster (Jan. 16th 1756) which secured Prussia's protection of the Electorate, and at the same time rendered her alliance with France abortive in the war between France and England which had practically already broken out. On May 1st 1756 France signed a defensive treaty of alliance with Austria. Maria Theresa knew that she could rely on Russia and Saxony, and it only remained to convert the defensive alliance with Austria into an offensive alliance, and Prussia could be attacked

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by Russia from the North East, by France from the West, and by Saxony and Austria from the South.

Frederick did not wait to be attacked; he sent a peremptory ultimatum to Vienna and received an evasive reply. On Aug. 26th 1756 he crossed into Saxony to clear his right flank for a decisive blow in Bohemia with the intention of maiming Austria before the French or Russians could intervene. Thus began the Seven Years War.

In many respects the political grouping and the "war aims" were of a complex and even obscure character, but the dominant issue was clearly for the Allies the dismemberment of Prussia and her disappearance as a disturbing factor in European politics. For Frederick the issue was literally the continued existence of Prussia as a European State: he fought for the salvation of Prussia, and this was the inspiration of his strategy and of his titanic efforts: without him, the struggle would inevitably have ended in disaster, and the final result was due even more to his adamantine and inexhaustible will and nerve than to his military genius. The first two years of the war made great gaps in Frederick's army; the English Alliance and the Anglo-Hanoverian Army under the Duke of Brunswick secured his right flank after 1757 with increasing effectiveness, but from 1758 onward the Austrian forces steadily improved in quality and Russia and Sweden had both joined the coalition in active offence, while Hesse, Brunswick, and Gotha were the only allies upon whom Frederick could rely. After some successes which were as costly as defeat, and defeats which were almost disastrous, the genius of Frederick rose to a supreme height in the defeat of the Franco—Austrian Armies at Rosbach (Nov. 5th 1757) followed without a pause by the defeat of the Austrians at Leuthen.

Continuous fighting in 1758 brought Frederick's army to the defensive from sheer exhaustion.

1759 was a memorable year for England; Quebec, Minden, and Quiberon being placed to her credit; but it was a disastrous year for Prussia. Russian and Austrian armies were living on Prussian provinces and on Saxony; the Swedes too were encamped in Western Pomerania and the Uckermark. Despite the great depletion of his resources, Frederick brought together for the campaign of 1760 about 100,000 men,—that is 50,000 fewer combatants than in 1757 and 1758, but nevertheless an astounding feat of organisation. The enemy force amounted to 223,000 combatants and their first strategical objective was Silesia.

The Silesian campaign of 1760 opened badly for Frederick. On June 23rd the Prussian Corps of 11,000 men which guarded the passes into Silesia near Landshut, was annihilated by superior forces, after heroic resistance. On July 26th the Fortress of Glatz capitulated. But the allies success was checked on Aug. 15th at Liegnitz, where Frederick scored a decisive success against the Austrians and captured 4000 prisoners and 83 guns. This battle did more than anything else to restore the morale of the Prussian Army, though it did little to improve the economic situation, and the material conditions. Berlin was occupied by 40,000 Russians and Austrians in

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eration set in, partly attributable no doubt to the fact that Frederick the Great, having made himself indispensable to Prussia, omitted to train his successor, or his Ministers, to carry on the traditions which he had created; with his declining powers, his mistrust and jealousy increased, and prevented him from the smallest measure of decentralisation or delegation of his autocratic power to others. Partly also, was the decline of Prussia due to a natural reaction from the intensive cultivation of a Spartan Militarism, which subordinated everything to the efficiency of Prussia as a Great Power: Frederick never knew what happiness meant, and the joy of life was not for his subjects during his reign, they had to live for Prussia without thought of themselves.

Under Frederick William III who succeeded his Father in 1797, the decline of Prussia became more marked, and the lowest point of national degradation was reached at Jena and consummated by the Treaty of Tilset 1807.

But from this point a new element found its way into the remaking of the Prussian State; a small band of brilliant statesmen and soldiers of whom Stein, Geisenau, Scharnhorst, Humboldt, Hardenburg were the most prominent, achieved the formation of a responsible ministry—their objective is thus defined by Sir Robert Morier. It was "to substitute an organic whole in its entirety for the inorganic machinery which had gradually been rotting since the death of Frederick the Great, and was now happily once for all broken to pieces."

This was what Frederick the Great had lacked; he had the failings of his qualities; he remains for all time the most brilliant example of devotion and success in "a one man job"; but he was a Commander without a General Staff, a King without a responsible Ministry, and therefore—failing a successor of calibre equal to his own—it was inevitable that decay should set in, as soon as his compelling personality was removed from the control of the State.

But the great qualities of discipline, endurance, and self sacrifice, which characterised his whole reign, and which he forced his subjects to acquire, have left their mark indelibly impressed on the Germany of to-day; and it is well that we should realise, that a nation which is thoroughly imbued with the spirit which enabled Frederick to emerge from the Seven Years' War without the loss of an acre of territory, is one which can never be beaten except by the exercise in equal or superior measure of those same qualities, by those who contest her arrogant claim to rule the world.

I am addressing an audience which does not require any argument on my part to convince it of the justice of this conclusion; but each individual in the audience has to accept responsibility for the exercise of his or her influence on their environment; and if, by any words of mine, I can help to direct that influence, I may be forgiven for insisting on what must already be obvious to everyone in this theatre.

The decision of the Supreme War Council at Versailles that "the prosecution of military effort is to be the *only* immediate task of the Allied Governments" will probably commend itself to everyone present: but this decision was made the subject of an amendment

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to the address, in the middle of February, by Mr. Holt, who found 28 supporters: the 28 are dangerous as propagandists. The plausible idea of a revolution in Germany to depose the Kaiser and the militarist ruling class, was disposed of on the same occasion by Mr. Adamson, another Labour Member, who concluded his speech as follows:—"The last of the belligerent nations where revolution would take place was Germany, and if there was revolution in this country and no revolution in Germany, it spelt disaster for this country."

May I conclude by quoting from Mr. Rudyard Kipling's admirable address at Folkestone on February 13th:—

". . . If for any reason whatever we fall short of victory—and there is no half-way house between victory and defeat—what happens to us? This. Every relation, every understanding, every decency upon which civilisation has been so anxiously built up will go—will be washed out, because it will have been proved unable to endure. The whole idea of Democracy—which at bottom is what the Hun fights against—will be dismissed from men's minds, because it will have been shown incapable of maintaining itself against the Hun. It will die; and it will die discredited, together with every belief and practice that is based on it. The Hun ideal, the Hun's root-notions of life will take its place throughout the world. Under that dispensation man will become once more the natural prey, body and goods, of his better-armed neighbour. Women will be the mere instrument for continuing the breed, the vessel of man's lust and man's cruelty; and labour will become a thing to be knocked on the head if it dares to give trouble, and worked to death if it does not. And from this order of life there will be no appeal, no possibility of any escape. This is what the Hun means when he says he intends to impose German Kultur—which is the German religion—upon the world. This is precisely what the world has banded itself together to resist. (Cheers.) It will take every ounce in us; it will try us out to the naked soul. Our trial will not be made less by the earnest advice and suggestions that we should accept some sort of compromise, which means defeat, put forward by Hun agents and confederates among us. (Hear, hear.) They are busy in that direction already. But be sure of this: Nothing—nothing we may have to endure now will weigh one featherweight compared with what we shall most certainly have to suffer if for any cause we fail of victory." (Loud cheers).

NOTE—The following authorities have been consulted:

"Frederick the Great" by T. Carlyle.

"The Evolution of Prussia" by Marriott & Robertson.

"Cambridge Modern History" Vol. VI.

THE CHAIRMAN: As no one appears to wish to ask any questions of the Lecturer for the purpose of deriving further information on any points he has brought forward, it remains for me to move a vote of thanks to General Stone for his interesting Lecture. I am afraid that we have not a large enough audience this afternoon, which I very much regret, or we might have got somebody up to

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raise some other aspect of the case that might have drawn a little more information on some points from the Lecturer himself—not that what he has given us is not very complete, but it is of a historical nature and therefore many of us (I for one) do not feel so well skilled in the history of those times as to be able to appreciate it at its full value. But there is one thing that is perfectly clear to all of us and that is the comparison he has drawn in the attitude of Prussia as she came into being under Frederick the Great and the attitude of Germany as she stands to-day before the nations of Europe; and also what is our duty as members of those nations allied together in the interests of liberty and life you may say, and what is our duty both as nations and as individual members thereof. I think you will all join with me in according a very hearty vote of thanks to General Stone, coupled with our regrets that we have not had a larger audience. (Applause).

GENL. STONE: General Cleeve, Ladies and Gentlemen: I thank you very much for your warm reception of my Lecture which quite makes up for the smallness of the audience. I did not feel discouraged any more than Mr. Pemberton Billing has felt discouraged by some of the small audiences in the House of Commons. I am quite sure from the very kind way in which you have received my efforts that I have succeeded in not freezing you.

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A USEFUL ACCESSORY TO MINIATURE RANGES.

By Temp. Major W. H. Wilson, d.s.o., R.F.A.

ONE of the drawbacks to Hill's and other Miniature Ranges is the difficulty experienced by the operator in memorizing corrections for Line, especially at Battery Fire. To obviate this difficulty I have designed what may be termed a "Deflection Recorder", which I venture to think will be found to increase the utility of these ranges. At all events it appreciably facilitates the work of the operator. The recording of alterations in range presents little or no difficulty.

The instrument consists of a hard-wood frame about 15 inches by 5½ inches, containing a Zero Line slide and an All Guns slide. In the All Guns slide are 6 longitudinal grooves, in each of which is an individual gun slide. The zero Line slide is graduated—on a scale of 1° to the inch—to cover an arc of 15°. (N.B. Care must be taken that the objective does not exceed an angular distance of 7° 30′, from the Zero point). The All Guns slide provides for an error in the angle ordered by the Ranging Officer up to 5° right or left and a further 5° "More Left" for distribution.. This should suffice for practical purposes, but, if necessary, the arc may be increased by lengthening the Zero Line slide. It is not advisable to reduce the spacing of the 5′ intervals.

Fig. I. represents the Recorder, ⅝ size, in plan, and Fig. II. a transverse section of it.

Opaque zylonite strips, graduated as required, and fastened with small metal pins, give the Recorder greater durability and a more finished appearance, but strips of white cartridge paper, varnished, will answer the purpose.

To use the instrument with Hill's Miniature Range, measure with the Pantograph on the Chart the angular distance of the objective from the Zero Point and move the Zero Line slide until the O.K. Line coincides with that angle from Zero Line. Next, adjust the individual gun slides for parallel lines, No. 1 (pivot gun) being aligned with the red arrow on the All Guns slide.

The Recorder is now set ready for ranging. When the Ranging Officer has given out the angle, set the red arrow on the All Guns slide to this angle from Zero Line and adjust the individual gun slides for any concentration or distribution ordered from parallelism. (N.B. The difference, if any, between the red arrow on the All Guns slide and the O.K. Line is error due to incorrect calculation of the angle by the Ranging Officer).

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Fig. III. shows the Recorder when the angle ordered is 3° 20′ right of Zero Line—the correct angle being 4° 50′ right—with a distribution of 10′ from No. 1 at 3600 yards.

In subsequent deflection corrections for "All Guns", the All Guns slide will be moved the ordered amount M.R. or M.L. When the correction is for individual guns or for sections, the individual gun slides will be moved.

With the Recorder before him the Operator can see at a glance the line of fire of each gun and move the pointer of the Pantograph accordingly.

The Recorder may also be found useful for checking lines at gun drill and in laying tests.

PRÈCIS OF
REVUE MILITAIRE SUISSE.

By Captain G. de L. Landon, m.c., R.A.

January, 1918.

The moral of our army.

An article by a Swiss attaché to one of the belligerents, describing his impressions of the Swiss Army and its moral, contrasted with those he had received during several months amongst the belligerent armiès.

Shell-holes.

The uses of shell holes in attack and defence, pointing out the large extent to which they are employed by both sides, and their advantages and disadvantages as compared with regular entrenchments.

United States Chronicle.

The new organization of divisions and regiments. The main sub-divisions of the U.S. Army. Their respective values. The cantonments. The numbering of divisions, brigades and regiments. The officers. The High Command. The "Rainbow" division.

Japanese Intervention.

A discussion of the chances of Japanese intervention on land. After examining the reasons for and against such intervention on the various fronts the writer reaches the conclusion that the only practicable fronts are those of Mesopotamia and Palestine, and considers that the Allied troops there should be withdrawn to reinforce Italy and Salonika, and the whole conduct of operations in Turkey in Asia handed over to the Japanese.

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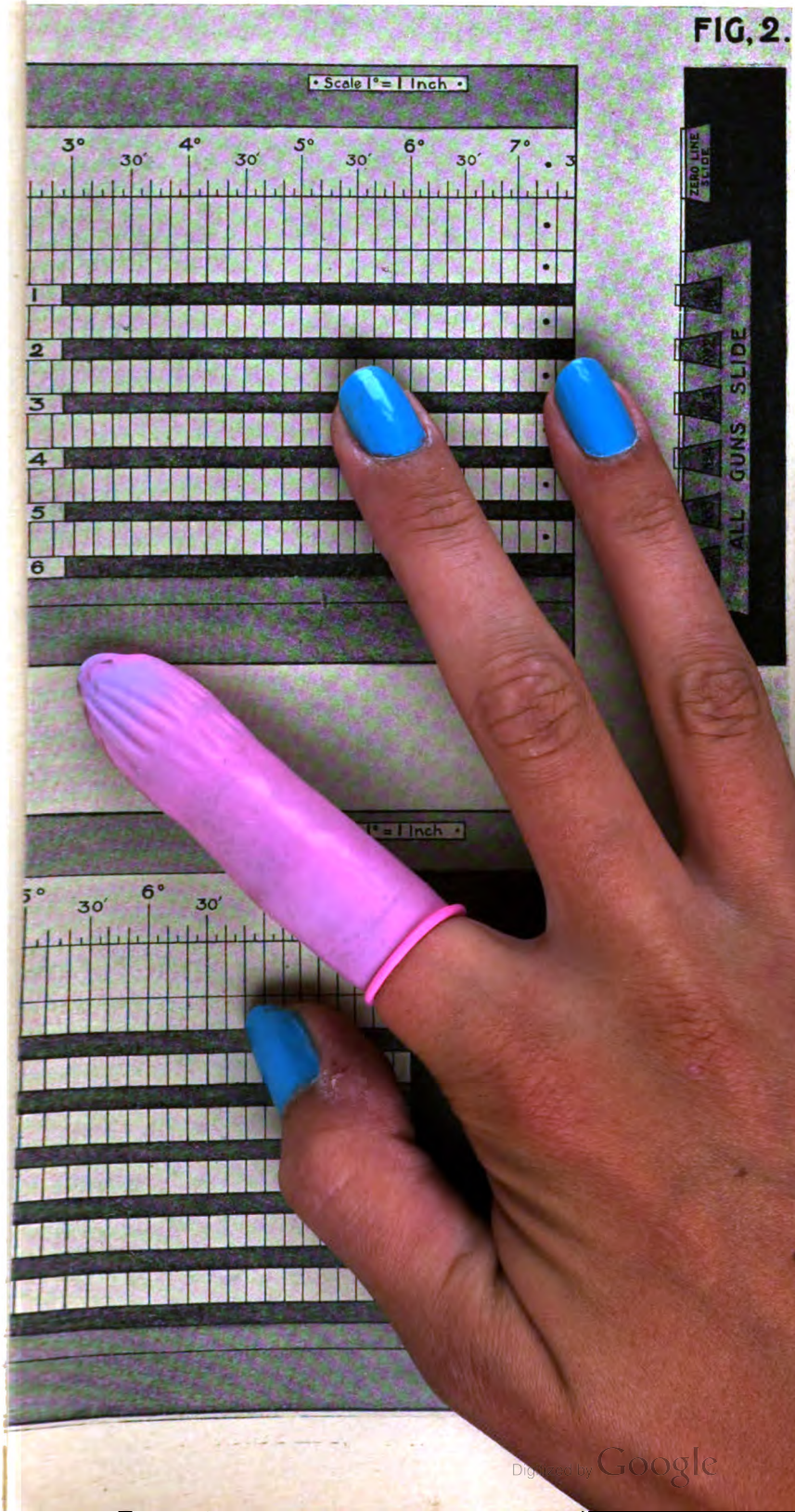
FIG. 2.



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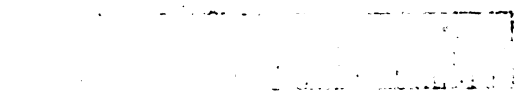

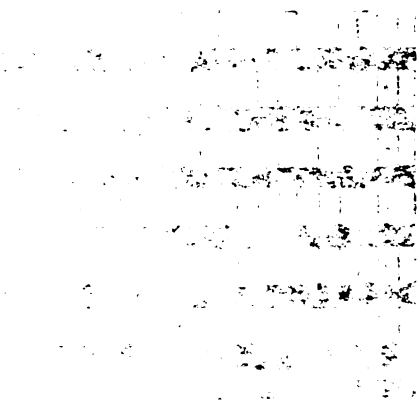

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Contents of R.A. Journal, May, 1918.

Horse Management in the Field. A Lecture delivered at the Royal Artillery Institution, Thursday, 14th March, 1918. By Colonel E. A. P. Hobday, C.M.G., R.A. Brig.-Genl. A. Stokes, C.B., C.M.G., D.S.O., R.A. in the Chair. 41

Relative Calibration by the Corrector. By Capt. B. M. G. Butterworth, M.C., R.G.A. 60

The Gunners Rule. By Sagittarius. 63

The 'Bearing' Method of Laying for Line. By Temp. Capt. L. A. Notcutt, M.C., R.G.A. 65

Locating Positions on Maps. By Major J. Powrie, R.H.A., (H.A.C.). 69

Surveys of the English Coast 1779-1793. From records of reports made by the Inspector of Royal Artillery on the Coast Defences of England. By Major A. E. Macrae, *pac.*, R.A. 73

"Brain re Rule of Thumb." (A Reply). By Major A. E. C. Myers, R.G.A. 87

Prècis of Revue Militaire Suisse. By Capt. G. de L. Landon, M.C., R.A. 88

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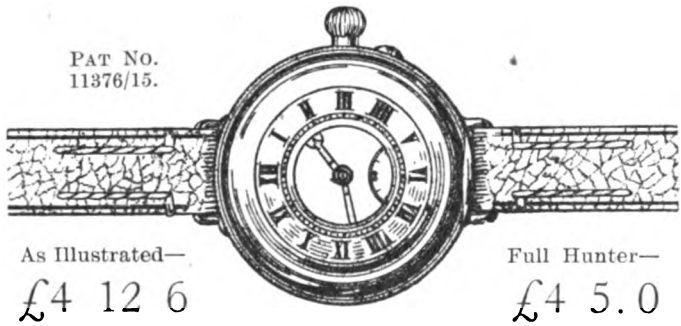

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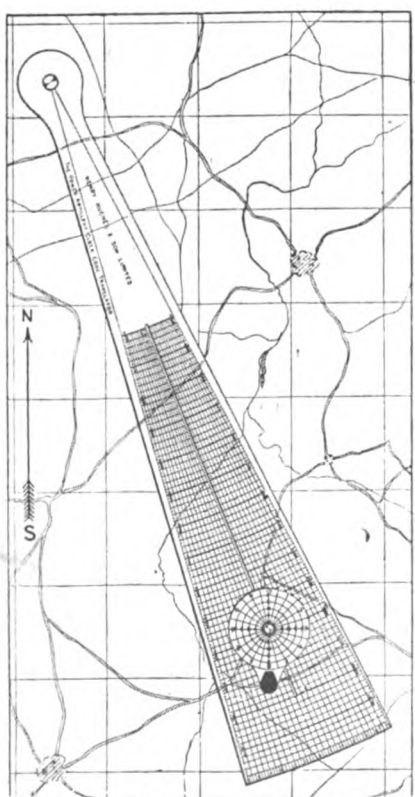

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HORSE MANAGEMENT IN THE FIELD.

A Lecture delivered at the Royal Artillery Institution, Thursday, 14th March, 1918.

By Colonel E. A. P. Hobday, C.M.G., R.A.

Brig.-Genl. A. Stokes, C.B., C.M.G., D.S.O., R.A. in the Chair.

THE CHAIRMAN: Gentlemen: I hardly need introduce Colonel Hobday; he is well known to most of us. He has spent a great many years in the Regiment and has been lecturing a good deal among the schools in France; he has had great experience out there with horses and I am quite certain he has got a great deal that is interesting to tell us. I will ask him to give his lecture. (The Colonel was drawing on the blackboard.) He is a great hand at that sort of thing. (Laughter and great applause).

Col. Hobday: General Stokes and Gentlemen, you know that good stable management at all times consists in paying attention to a large number of little details; but on service those details become more important even than they do in peace time, because the neglect of any of them results in loss of efficiency, and affects the health and comfort of your animals. Now the great thing we have to avoid out at the Front is wastage in horse flesh. There is a great deal of avoidable waste owing to neglect, and horses not being taken proper care of, or not being treated in time for little things, and the unit which has a lot of animals in its sick lines, and whose horses are constantly being evacuated or laid up is a unit which cannot have good horse management. If you can say that you have in your sick lines nothing more than a few unavoidable cases, kicks, bites, or picked up nails and things of that sort, you may be pretty sure that your horse management is all right.

Horse management depends upon two things. The first is instruction of officers and men in sympathy, good treatment and knowledge of the animal, and the second consists in having a good routine and a system of care of the horse in details, such as feeding, grooming, watering, and everything affecting his comfort. The first is the most important, because everything hangs on personal sympathy and knowledge of the horses by officers and men. In this war especially you find that most of your recruits, the drafts you get, and of course a large proportion of the new officers too, have never had anything to do with horses before they came into the service. In the South African war there were still in England a large number of grooms, ostlers, stablemen, van drivers, and people who had had a great deal to do with horses, and in the mounted branches we were

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pretty sure that a large proportion of our recruits were men who knew something about horses or had some dealings with them. But it is different now. For every man who knows something about horses you find 20 men who know something about motor cars, because motor transport has largely replaced horse transport for pleasure and business in England; and you find that tells very much when you have to look after horses in the field. An ignorant man errs in many ways; he probably is either afraid of a horse, or he neglects him, and does not think about him, or else he treats the horse like a machine and is rough and brutal and unkind to him. In every case the horse suffers. The first thing I always do when I get a new draft—and I have taught my officers to do it—is to have the men out and teach them a little about the affinity of the horse to themselves—that is the first thing. You get a horse out and you tell the men "Now look here, you have looked upon a horse probably as a machine, you knock him about and think it does not hurt him. You think you cannot get him to do anything except by roughness, cruelty, or something of that sort. That horse is very nearly related to you, he has got every muscle and bone and inside machinery that you have." I always make them laugh by saying "You tell me you have not got a tail. I say you have, the only difference is that you have it inside you and it does not stick outside." "You must think of a horse's comfort just exactly as you would of your own, because a horse has got exactly the same feelings as you have, and you must study your horses, just as officers have to study their men, individually." An officer ought to know every horse that is in his charge and know his peculiarities. A horse may be greedy or lazy, excitable or vicious, or a dozen things, just the same as you are, and therefore men and officers must know their horses. So you have got to get a proper understanding between the man and the horse. You must tell the man that he must think of his horse's comfort, and whatever he is doing to think "How would I like it myself?" A horse will suffer from heat and cold and wet and hunger and thirst, and things like that just the same as a man; and you have got to rub it into your men to think of the horses all the time—and that is half the battle of horse management. Always drop on any cruelty, rough treatment or neglect, and make an example of the driver—never take "Please Sir, I lost my temper" as an excuse.

Patience is especially necessary when dealing with remounts—a new horse is like a new boy at school, a stranger to his surroundings. Take him quietly at first, put a good man in charge of him, and let him learn his work gradually and comfortably. He should be segregated for 14 days after arrival to guard against chances of infectious disease appearing.

Next, teach your drivers their "way about" a horse. How many of your men could put their hand at once on a horse's "Off hind pastern" if told to do so? If a driver out alone with a pair of horses on fatigue had an accident, and either or both of them was injured and had to be left out, he must be able to report exactly where their injuries are situated, so that proper help can be given them. Besides teaching him to know the name of every part of a horse, a few simple

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facts about the animals anatomy and chief organs will not be amiss, and will add to his interest in the beasts under his charge.

Now we come to another thing. The cause of a lot of wastage of horse flesh, especially on service, is that little things are not taken in time. Constant vigilance by officers and men is always necessary. You get a horse that is off its feed, or going a little short, or out of sorts in half a dozen different ways, and if nothing is said or done about it, in a week's time that horse's ailment may have developed into something that will cause him to be evacuated; whereas if it is taken in hand at once, in most cases with a little rest he will be all right for his work in a few days. But you have to teach your men that they must exercise an intelligent observation and have some knowledge of the conditions of a horse's health and welfare, and to report *at once* anything that is wrong with him. We all know the old proverbs "A stitch in time saves 9" and "prevention is better than cure,'" and that is nowhere more true than on service. You cannot keep a whole lot of horses sick on your lines, you must get rid of them; but if a horse has anything wrong with him and you take him in time, a little rest or nursing will generally put him right in a day or two. Unnecessary waste of animals is the thing you have to avoid.

A horse when he is in good health is intelligent and bright, he is always looking about him in the lines, he knows what is going on and takes an interest in everything—especially about feeding time, and his coat is smooth and glossy. But if he is sluggish and "rusty looking" especially if he is "off his feed", there must be something the matter—it may be some little thing, he may have a chill, or a touch of colic, or anything, but anyhow the man must discover it and report it at once.

Another thing by which the driver can tell his horses' state of health, and, which you must teach your drivers to watch is the horse's dung. In a horse's droppings you may find there are a large number of undigested oats. On service a horse's rations are very valuable, and very often they are cut down and he is on short rations; therefore you want him to have the value of every bit of food coming to him. If he is passing a heap of oats through him without their being digested he is losing all the value of that amount of feed, because, mind you, the nourishment of the oat is contained in the grain which is inside the outer husk, and that has to be masticated and broken up before the gastric juices can dissolve it and get its nourishment into the horse's system; if he is passing those oats through him undigested he is getting no value out of them at all. Now your driver can tell you at once "This horse is passing a lot of grain through him." It may be that he is a greedy horse who bolts his food, or he may have something wrong, he may want his teeth filing—but whatever it is the driver should notice and report it. Or possibly the horse may have very hard dark slimy droppings, and that means possibly that he is constipated and wants a little dose. On the other hand his droppings may be more or less liquid—a tendency to diarrhœa. This may mean simply that he has been having a lot of green food which has acted upon him as an aperient;

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or perhaps he has had a chill or something of that sort. Anyhow you can take the matter in hand in time—that is the thing—if it is reported promptly.

The driver should also watch the droppings to see if the horse suffers from worms. There are other things you must teach your drivers to notice promptly, such as running at the nose; always be sure that that is reported at once and the animal separated from his companions. It may be only a slight cold; anyhow he can be segregated and treated properly, and he will not get any worse or pass his complaint on to his neighbours. But it may possibly be something very serious. This discharge from the nose, especially if it is thick and whitish or yellow, may be that very dangerous disease glanders, which is most contagious and may run through the whole unit, and is also dangerous to men. So when you have cases of horses running at the nose teach your drivers when they are showing the horse not to stand immediately in front of it. If the horse had glanders and it blew or sneezed and snorted and blew some of the mucus on to the man it is quite possible that the man might get glanders too; therefore treat with very great suspicion any case of running at the nose, and do not let the man have a chance of getting any fatal disease. Any swelling under the throat or anywhere else should be reported at once. A horse "blowing" and looking round at his side has probably got colic. You do not want to teach your drivers to be veterinary surgeons, they are not the men to treat the thing; but they have to learn to keep their eyes open and be intelligent and report. That is the value of this part of horse management, that you can take the thing in time. The veterinary people will attend to the treatment.

A horse generally stands evenly on all four legs; you will see him resting a hind leg occasionally, but you will never see him pointing his fore-foot like that (describing on the black-board) for any length of time unless there is some sort of trouble in *that* leg; it does not matter to the driver what it is,—it may be a strained tendon or fetlock, it may be a bruised sole or a cracked heel, or foot trouble, or anything—get it looked to at once. Tell your driver also to look very carefully for any suspicion of skin disease when he is grooming, and to report it at once. Skin disease is always catching, and you may get ringworm or mange right through your stables unless it is taken in time. Ringworm you know—round raised blotches, if you pull the hair on them it comes out quite easily. It is a very simple thing to treat, you segregate the horse and clip the hair off the spots and treat the thing with iodine, and it is generally well in ten days or a fortnight. But things like mange may be very serious—we have a lot of it out at the Front, so teach your drivers to look at their horses and insist on their reporting at once if they are rubbing their tails against posts or rubbing the back of the neck or anything of that kind, because it may be the beginning of an outbreak of mange in your stables which you would not like. It is everything to segregate suspicious cases promptly. If wearing rugs try and let every horse keep his own to avoid spreading infection.

A solution of calcium sulphide, or cresol is a good thing to keep going in your stables all the time as a preventive of itch or skin

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disease. Have it well rubbed into the skin round the root of the tail, the heels and fetlocks, inside the thighs and on the neck and crest, and you will have very few horses rubbing themselves. I use it regularly and I have had no outbreak of skin disease during the war.

Again, the driver at every opportunity ought to examine his horses' feet. Out at the Front, especially along the roads, there are a tremendous lot of nails lying about—they often come from old boxes used as fuel in Infantry cookers—all the nails drop out on the road, and we suffer from a lot of picked up nails in consequence. So every driver ought constantly to examine the horses' feet and if anything is wrong, such as broken or twisted shoes, or a bruised sole, report it at once. He should also discover and report all wounds and galls.

You see what a lot of things connected with horse management the driver is responsible for and ought to know about. Then you must cultivate the driver's affection for his animals. As I said at the beginning, the horses health and comfort depends enormously upon the sympathy between the man and the beast. If a man is always thinking of his animal's comfort, if he makes his horse happy and comfortable, his horse will trust him, and when he wants any extra exertion out of the animal it will respond; but a horse that is rendered vicious or timid by ill usage or neglect will never do his best in an emergency. Therefore encourage your drivers always to make friends with their animals. There is nothing I like better when the drivers go down to the stables than to see all the horses put their heads round and whinny, because they know their friend is coming and that he has got a bit of bread in his pocket or something he has saved from his dinner for them; and on a march I like at any halt to see my drivers pulling a bit of grass from the hedgerows and giving it to their horses. It all counts. Comfort and happiness will make your horse more healthy and fit than you know of; while peace and quietness when not working, and good treatment are as good as many feeds to a horse.

So much for the personal equation; I shall refer to it again later. Now we come to the system. You must have good arrangements in your command for the well-being of the horse in his daily routine. There are four all important things which have got to be dealt with: Feeding, watering, grooming, and exercise, and of course other minor details connected with his life and surroundings that I will tell you of presently.

Firstly feeding. On active service, as I told you, you are very often cut down to low rations. Ordinarily one gets about 12lbs a horse as his oat ration, and frequently they cut it down to 10lbs.—that is not excessive for winter work, and I have been during this war as low as 7lbs. of oats per horse a day which is too little on service; therefore you have to watch carefully and avoid waste of every description; you must see that your horses get every bit that is coming to them, every grain of oats, every blade of hay, and as much as you can make besides illegitimately (laughter).

Now we will discuss that waste and the remedies for avoiding it. I will talk of oats first and hay afterwards. The oats come across

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the sea in ships and are knocked about on the quays and then in and out of railway trains till they reach railhead, and the sacks have a lot of handling and rough usage. When they arrive at the A.S.C. the people who supply you, you will find that a great many of the sacks are leaky or bursting, and when your N.C.O. draws your rations he will probably get a certain number of leaky sacks given him. I have seen at the Front trails of oats from burst sacks along the road, absolutely wasted in the mud; it is heartrending to see good horses' feed wasted like that; and I have seen oats dripping out of waggons because the whole floor was covered with oats that had leaked out of sacks. Now there is a very simple remedy for that. When your N.C.O. goes down with the waggon to draw forage, see that he always takes with him a few empty sound sacks, and if the A.S.C. hands him over any sacks that he sees are leaking, let him slip over them one of his sound sacks before putting them in the forage wagon, then you will not have a lot of oats lying all about the waggon probably to be swept out and wasted, and you will save many feeds. The next source of waste of oats is at your own forage shed or wherever you make up feeds. You know that when feeds are issued the nose bags are put on the ground near a sack of oats and filled, often by rule of thumb in two or three handfulls, or the more general way of using some measure such as a mess tin. However careful you may be, you are bound to spill a certain amount and when this has been dropped into dust or mud it is lost for good to the horses; therefore always make your forage orderly put down a blanket or tarpaulin when he is issuing feeds, and any oats that are then spilt can be collected and used again. It is a small thing, but I have seen instances of negligence of this little point so often—that it is necessary to be constantly on guard against it—Every grain of oats counts.

The next source of waste is leaky nose bags. Nose bags of course have to be scrubbed and are apt to get rotten from being wet, and burst at the seams. You must teach your drivers when nose bags are unserviceable like that to bring them up for repair or replacement at once. And in your unit wherever it is, you ought always to try and keep a reserve of sound nose bags in case of a sudden march, or to replace those under repair. The way to do that is not to wait until you have a lot of worn-out nose bags and then ask for 50 or 100 at a time, and probably be told by the Ordnance "You cannot have them—we can give you 20 or 30," do not wait for that, but always, whether you have nose bags inefficient or not, put in for a few every month, 10 here, 20 here, and always have some new ones up your sleeve. This may not be strictly legitimate, but it is sound policy. It is a most pitiable thing to see a leaky nose bag on the march into which the driver probably has stuffed a wisp of hay or something to keep the oats in. Presently he trots along to make up distance, and when he starts jogging out goes the wisp of hay, and that poor horse's feed goes into the mud. I have seen that dozens of times. Always try and start a march with sound nose bags, so that the horse will get his full ration on the road and none will be wasted. It is not a bad thing in order to save your nose bags, if you know you are going to be a long time at one place, to make a

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set of stable nose bags out of sacking or anything you can lay hold of, which are quite good enough to use in rest billets, you can then keep the sound service nose bags in reserve for a march or a move, and you will not have to draw so many.

There you see are three or four sources of waste. Another source of waste of feed is this, the excitement of a hungry horse that tries to bolt his feed. Horses are very intelligent. They know especially when on lines in the open when the feeds are coming, and when the feed whistle goes there is a good deal of squealing and kicking and biting—in fact a lot of avoidable casualties often occur about feed time unless you can do something to lessen the excitement of the hungry animals at that moment. When the nose bags are put on the horses will try to swallow as much as they can without masticating it, they toss up their heads and away goes half the feed, spilt. I will show you a remedy. It is a very sound thing during stable hours before or after watering to put down a certain amount of hay, and by letting the horses have this to nibble at, you will lessen the excitement and greediness when nose-bags go on. It keeps the horses quiet, and takes the edge off their appetite. Instead of squealing and fighting while waiting for their feed and tossing their nose-bags up and spilling a lot when they get it trying to swallow as much as they can at once, they begin on their oats quietly and comfortably, and masticate their food instead of bolting it. You also prevent a great deal of the possibility of accidents from kicks and bites.

Then we come to hay. Oats and hay are the chief nutriment animals get at the front, and hay is given in order to fill the horse's stomach. A horse must have his stomach filled to nourish him properly, and hay gives bulk. You could not feed horses entirely on oats, they could not digest their food if it was nothing but oats, they would get colic and stomach trouble of all sorts; therefore you give him a large bulk of feed as hay. Let me advise you whenever you are on service always to use hay nets. To lay hay down in front of a horse and let him pick it up as best he can is the most wasteful way of giving it. To commence with, he is sure to tread a certain amount into the ground. You know how horses paw and push back a lot of their hay if it is loose. Half of it is often wasted and blown away by the wind. There is another source of waste in giving hay loose on the ground. Try to save every bit you can of what you would call the "refuse" of a bale of hay. You know that if you take hay from the bale and tease and shake it out, a whole lot of so-called dust and little fragments fall down. All that so-called hay "refuse" is some of the most nutritious and valuable part of the hay bale; it consists of all the hay seed, which is the grass grain, just as the oats are the grain of oats; it consists of all the clover flowers and clover leaves and all the little leaves of vetch, that sort of thing that you get in hay, pieces of that dry brittle sort of stuff called sanfoin, and all those little bits of blades of grass and so on, all nutritious and valuable feed. If you lay down loose hay before a horse he cannot pick these little things up and they go into the ground and are wasted. The proper thing is to collect them first. If you arrange in

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your forage shed to have a trough made of a tarpaulin and when filling hay nets if the N.C.O. or forage orderly takes the hay out of the bale and teases it and shakes it over this trough before he puts it into the net, by the time all the nets are filled you will find you have a large pile of little bits of grass and what I have called "hay refuse" that will surprise you. Now that is an excellent substitute for chaff. Put it into the feeds and mix it up and the horses will get the full value of it. I have long pursued this plan and it is largely adopted out at the Front now. We save all that "hay refuse" that we can, and it adds largely to the bulk of the horses' feed. Never neglect to get every bit you can for your horses, from any source.

While I am on the subject of chaff let me say that you must always give chaff with your grain feeds. Every unit now has a chaff cutter, and that is one of our most valuable possessions. In the early days we had not all got them and we often wished we had. The use and value of chaff is that it makes a horse masticate his oats and prevent his bolting his food, so the chaff cutter is an important item in the horses health and condition.

Those are the main ways of getting the best value you can out of oats and hay, but a horse need not live entirely on oats and hay, he likes variety occasionally; therefore you ought always to study Orders, in which you will find published from time to time certain equivalents which you can sometimes draw instead of part of the ordinary ration. Bran is very difficult to get at the front but you ought always to have some bran for your sick animals or animals under special treatment. The value of bran is this. It has the peculiar property, of acting in a different way on a horse according to whether it is dry or damp. Dry bran has a binding effect on a horse. If a horse is suffering from diarrhœa, and loose, you give him dry bran, it will bind him. On the other hand, wet bran or bran mashes have a laxative effect on a horse. In old days one used to give one's horse a bran mash on Saturday night becuse you knew that he was not going to have much work on Sunday and a little clearing out once a week was a good thing before returning to his work on Monday morning. You can draw linseed when you want it by recommendation of the Veterinary Officer. Linseed you only give as a special feed to animals that are run down a bit when you want to put flesh on them. Linseed is given boiled. It makes a sort of gelatinous mess which you mix into their feed. Do not neglect the water the linseed is boiled in, it is very nutritious. Mix it with the feed too, "linseed tea" is just as nourishing as linseed itself. Then you may get oil cake, which is good for fattening up horses. In winter, hot feed of an evening is much appreciated if you can arrange for it.

I may as well say now as later the system that I have for horses to which you want to give special treatment. As I said, "a stitch in time saves nine" and early treatment of small troubles is everything. If a horse is a little off colour, "tucked up" or run down a bit in condition give him rest, take him out of work at once and do not let him remain among his companions. I always have what I call a "rest line" (as distinct from "sick lines") for any animals on special

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treatment that want a little peace and quiet—rest is as good as extra food to a horse—and I put that line in full charge of a good N.C.O. You will probably find a promising bombardier or corporal working up for his promotion. If he is trustworthy and fond of animals let him show what he is made of, put him in charge of that line and make him responsible for all the treatment, feed, and exercise of the animals. It is generally an unpopular thing to take animals out of their section because the N.C.O's say "We can treat them ourselves and look after their feed and all that just as well." But that is a fallacy. You will find probably on some dark night some ailing horse has gone out all night on fatigue and next morning you find a wreck come home who will be laid up perhaps for a month, you say, "Why was that horse sent out?" "Oh, I beg your pardon, he went out by mistake." But the mischief is done. If you put your horse on a "rest line" you will be certain that he will not be treated in that way. If they are left on the service lines you will find too that they will always be fidgetted and worried by fatigues coming in at all hours, drivers cleaning harness, etc. and they do not get the rest they ought to have. So it is wiser to have a special line for any horses that require special treatment.

Now I will go back and finish up with the feed. You may find in Orders that you can get carrots or beets or something of that sort, and in some places where there are breweries, like Armentières, you may be able occasionally to get a little brewers' grains. I have never got maize in France. I wonder why? I fancy it is owing to the trouble of transport and difficulties of crushing (it cannot be given whole) but I have never been able to get maize, Indian corn. It is very good to mix with oats if you can get it, especially during winter as it is a warming feed, and cheaper than oats. During the Summer months you are certain to get a lot of green fodder; you will get green oats cut from the field, peas, or beans, vetch or clover, given you by the A.S.C. There are very good clover fields and I have had the cutting of a lot of them. But you must give green food with discretion; as I said earlier in the lecture, green food is apt to scour a horse, and too much is bad for it. Therefore have a large proportion of dry hay mixed with your green fodder whenever you get it; and when it is pease or beans it is wise to put them through the chaff cutter and give them as chop with other feeds. By mixing green fodder with dry hay, you will find your horses will not suffer from it.

Always give salt. Salt is essential for a horse's comfort. I have seen some units use a salt trough, for their horses to put their noses in and have a lick when going to and from watering. Others mix salt with their feed. In either case the horse should always get his salt. Try and add to your feed by anything that you can get in the way of grazing; there are lots of opportunities of grazing at certain parts of the Front. Where I am now, in the area which was evacuated by the Germans last year, you can turn your horses out all day for good grazing. At other places you may find a difficulty, and you cannot get grazing; but if you cannot get grazing always try and get the grass. I used to do it by sending out a waggon with some drivers with sickles and sacks to cut the grass in the lanes and hedge-rows and bring it in. But when you can get it always give

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all the grazing you can to your horses, because it is a great addition to their ration and they love it. The freedom, and a chance to roll, are very good for them. So much for feeding.

Now I must get on to the next point—watering. Watering is one of the most important factors in a horse's health, and it is a thing which is slurred over or neglected more than any other at the Front. A horse wants to take his water quietly, and comfortably, and therefore you must have proper system of watering and not let them crowd on to the trough anyhow. Always have an officer in charge of watering, or at any rate a responsible N.C.O. He ought not to let more horses go up to the trough than can drink there comfortably; each horse needs about five feet of space, and if possible—I do not say it is always possible—do not water from both sides of the trough at once. Animals, mules especially, are very sensitive about being interrupted in their feed or watering—they will not drink if they have another animal shoving its nose in from the other side of the trough. So try and water them only on one side. Do not let the next lot to come on get up too close to those drinking—it fidgets and worries them; and do not file away till every horse has had as much as he wants. When a horse throws his head up the first time do not be content with that, he may want to have another swig at it, let him have it. Be quite sure that every horse gets all he can, and as long as any horse has his nose in the trough do not file that lot away, and do not let the next lot come pushing in till the others are clear.

Be very careful to give as clean water as possible. Teach your drivers, especially when they are out on fatigue, not to water from any dirty puddle. Horses, like yourselves, prefer their drink clean—mules especially are very sensitive about water; they very often will refuse water that a horse will drink gladly.

Another thing which applies to both watering and feeding is that your rule ought to be "Little and Often". It is far better when you are on the march, if it is going to be a six hours march, to divide it into two; at the end of three hours water and give a half feed, and at the end of the other three hours water and give the other half feed; that is far better than working them the six hours on end without any refreshment at all. With the ordinary routine in the same way, try and spread the watering and feeding over the whole day as far as possible; four feeds are better than three. And always try to shorten your horses' long nights. You will find units sometimes that give nothing at all between 4 or 5 o'clock in the afternoon and 6 or 7 next morning; that is a very long time to go, and especially when the horse has to be out in the open in inclement weather. A horse's vitality goes down and he feels the rigours of the climate more at night, especialy towards morning if he is a long time without his grub. Food always means warmth, and for that reason I try to give a little hay last thing at night as late as I can make it, and always the first thing in the morning before even you start grooming at morning stables. In the same way in the day time spread out your feeds, and in hot weather give extra watering late in the evening; it is more like what the horse is accustomed to in a state of nature, when he is nibbling or drinking all day as he feels inclined. You must

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always remember that a horse in civilisation is a prisoner, and he is tied up all the time he is not working. You must teach your drivers that their horses are entirely dependent on them for their comfort and happiness, and if a driver neglects his horse that horse suffers. A horse depends for his food, exercise, and water entirely on a human being, so that if the man is negligent and does not look after his horse, you must fix the responsibility on him and deal with him accordingly.

Now we come to the third point, which is grooming. All skin disease arises from dirt. If any of you never washed for a month or more, or changed your clothes, and sweated all the time with hard work, the pores of your skin would become clogged and you would very likely come out all over in spots, and be sore and itching. It is just the same with a horse; dirt induces skin disease, and every horse ought to have at least one thorough grooming a day. When I say one thorough grooming I mean cleaning the pores of his skin thoroughly and getting rid of scurf with a brush. In order to do that you very often find you have to make special arrangements. On service we are nearly always more or less short handed; we have to supply men for trench work and all sorts of fatigues and outside duties, and very often you find yourself with one man to about 6 or 8 horses. Now no man can groom 6 or 8 horses properly in one stable hour, therefore my system is always this. I know Nos. 1 and section commanders do not like it, but the only way to have effective grooming is to pool your men. If you only have a few men turn them all on to one section at a time. Do every horse thoroughly in one section one stable hour, then in the next stable hour the next section, and the next section in the next stable hour; by that means you can ensure all your horses being well done at least once a day. That is very important, because skin disease is a thing we have to guard carefully against out at the Front.

Next in importance to the brush is the wisp. You may not be able to keep up straw wisps—you may not be able to get straw, but wisping is of the greatest value in regard to the horse's condition; it is massage, and you know when anybody is training for rowing, running, boxing, or any athletics, the muscles have to be brought up into condition by massage. Wisping in the same way hardens a a horse and turns fat into muscle. Massage all over is the very best thing possible for "condition". Just as effective as a wisp is a thing not half enough utilized as it should be—a man's own hands. In India the Syces (native grooms) groom almost entirely with their hands; you will see a Syce grooming a pony with the heel of his fist and the flat of his hand, and getting all the sweat and dirt and scurf out of him with nothing else. The value of the use of the hand is not half enough understood in our service. On a cold frosty morning massage, patting and hand rubbing of legs and ears is far more valuable than tickling with a brush, because you get the horse's circulation going, and you get him warm and feeling happy. Hand rubbing, especially the ears and legs, and patting by hand all over is most valuable. A horse that is hot or wet after he is rubbed over with a wisp of straw, or a horse rubber, can be dried quickly by

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rubbing and working over him with the hand, because you get the circulation going, and his natural warmth helps.

When a horse is standing in mud and wet, as they very often have to do, you cannot do very much in the way of drying his heels and legs, but if he is on brick standings or under cover you should always try and keep his feet and legs dry to avoid cracked heels—For the same reason in Winter—I do not say in Summer—you never ought to clip the long hair off the legs and fetlocks; that is the natural covering put there by nature to keep the wet out of the skin of his heels and fetlocks. You know what happens if you put your hands in hot water and wash them and then go out on a frosty day without drying them on a towel—they get chapped and cracked. In the same way if a horse gets wet into the skin of his fetlocks and heels he will get sore and chapped; therefore if he is not standing up to his hocks in mud always try and dry his heels and legs when he comes in wet, but never let your drivers wash the mud off. If a horse goes through mud and water and slush with that natural protection of long hair on him a great deal of wet runs off and is kept away from the skin; but if you wash him and let the man go rubbing the wet in, you are bound to wet the skin, and there is more danger of his getting cracked heels than there is by running the chance through his standing in wet or mud. So do not *wash* the mud off—let the mud dry and then brush it off.

If a horse comes in with his coat wet from sweat or rain do not let him stand in a draught or a high wind—put a blanket or something over him and keep him out of a draught. The sheaths of geldings should be cleaned out and washed. This is often neglected.

We come next to exercise. Exercise is essential. You may find the legs of animals that are kept in stables become very puffy and filled; if so, make your mind up at once that in nine cases out of ten it is owing to want of exercise. If a horse is always standing still in a stable, or left there too long and has not enough work, his legs fill. If a horse does not get exercise in the ordinary course of his duty he must go out—you must send your horses out for about two hours steady walking exercise daily; you need not do much trotting—it is not allowed out there, on the roads as a rule, but a long steady walk will keep him in good fettle and produce muscle on him. It also exercises his bowels, because a horse will drop dung much more freely when he is out at exercise than when he is in the stable—a good thing for his health and digestion.

While I am about it I may as well speak a little about "Exercising Order" Exercise, especially "early" exercise very often made a slovenly and useless sort of entertainment. I have seen sometimes a large string of horses crawling in a ring at a snail's pace just outside their lines with one man leading about 4 horses and the drivers riding bareback with a cigarette behind their ears, sitting anyhow, their coats all open and nobody caring a damn what is happening. That is about the worst form of exercise you can have. Exercise can be made a most instructive and useful thing out at the Front. For the first thing do not let the men ride bare back more than they can help. A horse is not meant to be ridden bareback, saddles were invented in

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order to avoid the disadvantages of riding bareback. There are two hard bones in a man's buttocks which will make the horse very tender, if he is ridden very much bareback, also the top of his spine is apt to be rubbed and become sore. Riding bareback for a short distance does not much matter when going to the water trough or the forge, but if your men and horses are going outside the lines always let them be a credit to the regiment, and your unit. Have your men properly turned out and properly dressed; have your horses looking their best and have the "riders" saddled. It is much nicer if you meet a General at exercise to have him say "What unit is that?" Ah, very good—good horses—"nice smart turn out" and not to hear afterwards that he had met a "slovenly crowd" which turned out to be your command. Always let your exercise be something useful and smart, and a credit to the unit. Officers can always make exercise a very good opportunity for instruction for the N.C.O's and the men. You can teach a lot of road discipline at exercise and also learn your way about the country. At the front it is all important for artillery units to know every alternative route, road, and cross country track from the wagon lines and reserve billets, to the battery positions in the front line. You must study, and get your N.C.O's and men to know all the routes everywhere in your area. Suppose you got an order to retire on X say, and avoid the main road because it was congested with other trffic what would you do if you did not know where to find an alternative route, or were told to get across a river or stream in a hurry and did not know the bridges? One of my subalterns gained the M.C. at Ypres for getting ammunition convoys to the gun positions at night on two occasions, by alternative routes he had reconnoitred; when the main roads were barred by shell fire. No other columns got through. Always have a good N.C.O. at the head of your exercise and one at the tail so that the horses are not tried by jogging and trotting in having to close up. You learn a lot about pace; the most important thing in marches, remember, is that the head of the column has got to go steady. So much for exercise, I will not go more into that. If you ever get hold of a pamphlet by Sir Lawrence Parsons on the subject, read it.

Your lines may often come under long range shell fire or night bombing by aeroplanes. When the Hun shells the "back areas" he generally works up and down along one bearing, and seldon "sweeps" If his line of fire endangers your animals the best thing to do is to clear out to a flank till it is over. Practice your men in "standing to" smartly and getting their animals away quickly and quietly in an orderly manner. In the case of air raids of course you must take your chance. A good precautionary measure is to make sandbag traverses to minimize the spread of the explosion, and if possible, lay out your lines wide apart so that damage will be confined to only one stable or row of beasts. If you get a bomb into your lines, get the men to the animals at once. See that any poor beasts that are hopelessly maimed are promptly shot and let the men remain with their animals a little while to restore their nerve and confidence. Mules are particularly sensitive to shocks like shelling or bombing.

A horse, as I said, leads an artificial life; he is more or less of

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a prisoner and the most artificial thing about him is that you have got to nail bits of iron on to his feet before you can work him. Now every officer and every N.C.O. ought to know something about shoeing; the comfort of your horses depends largely on good shoeing. I told you about the similarity of a horse to a man in every way. When I said that he had got everything that we had got, the only thing he has not got is five fingers—he has only one for each limb. Teach your men this. Here (drawing on the blackboard) is the horse's forearm, here is his elbow, here is what you call his knee, which is really the same as your wrists, and then here is his one finger which comes down below the wrist or knee. That bone there, is the cannon bone, the same as the bones in the back of your hand—then the fetlock—corresponding to your knuckle—then these bones here like the finger bones, and last of all his hoof, which corresponds to your nails exactly. In the same way the hock is your heel. Let us see how that applies in shoeing. Your nail is insensitive, so is the horn of the horses hoof. In the same way as you can cut your nails with a pair of scissors, so in the case of the horse you can drive nails into the horn and cut it about with a knife or rasp it or do anything to it without causing pain. The horn is of a certain thickness, but inside that outer layer of horn there is an inner layer of white sensitive material which corresponds exactly to the little white part of your nail which is the "quick" of the nail. When a horse is said to be pricked in shoeing the nail has been driven through the outer horn into the sensitive layer behind, so you see what care must be taken in shoeing to avoid driving the nails inside the horn and how necessary it is to leave horn of a sufficient thickness to let you drive nails without hurting. Now the first consideration in shoeing is that the shoe must fit the foot and not that the foot must be pared down and rasped down to fit the shoe. Suppose that foot there (drawing on the black-board) had a shoe put on that was too short or narrow and then the farrier or shoeing smith went and rasped it down like that, look how near you come to the sensitive inner layer of the hoof, and on the side here if you have to put nails in, there will be a danger of pricking "the quick" the next time the horse is shod. That over rasping is called dumping, and you must watch your shoeing to see that it is not overdone by the farrier. In connection with that I want to say now that you must show your farriers and shoeing smiths that you take a *personal* interest in their work. I know what officers say "He is a specialist, it is his job not mine; I cannot teach him anything" and they never go near him or bother themselves about how their animals are shod. But that is all wrong. You must know yourselves what encouragement means. In the service if your drivers and N.C.O's or artificers see that you appreciate their work and take an interest in them it encourages them, and they do twice as well. If you can learn something about shoeing yourselves, so much the better. Go into the forge, watch it, and some day get the farrier to let you tackle it, and you will be much more fitted to criticise it then; but in any case show that you appreciate what he does. If you find fault with him and he sees you are right you will have gone up in his estimation ever so much, and in any case you will learn a great deal yourselves. See that the shoes are not fitted too

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wide especially on the inside—they ought to fit exactly—and they ought not to be too narrow at the heel and pinch the frog. When shoes are nailed on the points of the nails that project are turned over and form what are called "clinches" to hold the shoe on. You must watch that the clinches do not project and are rasped down so that the horse cannot cut himself if he is inclined to brush. See that clinches are properly cut to enable the shoe to be removed, when renewing shoes. Careless shoeing smiths are sometimes apt to pull off a shoe without doing this, thus tearing and weakening the horn, and making it difficult to drive new nails. You must not have the shoes too long behind or the horse will be apt to tread on them if he overreaches; if he treads on the projecting heel of the shoe it will bring the horse down and probably tear the shoe off. When a horse is shod the hoof ought to be pared down and prepared, as the horn, like your nail, grows all the time. You should take special care that this is properly done in the case of mules. Mules seem to grow their horn rather quicker than horses and shoeing smiths are rather careless about paring down, and therefore they are much more apt to leave mules with a foot like that (drawing on the blackboard). A long narrow foot, as if he was standing on his toes like a lady in high heeled boots. It is quite possible to shoe a mule almost exactly the same as a horse. Do not have him standing on the point of his toes; he gets much more concussion on hard roads and you do not get the advantage of the play of the fetlock and pastern, meant by nature to avoid this sort or shock. It is always a very good thing if you are in charge of animals to inspect those that have been shod during the last 24 hours in the evening stable hour when the farrier or shoeing smith has done his work for the day. Look at every foot with him and see that his work has been good. In Winter always have frost cogs and nails ready for a sudden cold snap. You may be called upon, as I was last Christmas, to march at a minutes notice in hard frost and snow, and if the road is as bad as we had it then you and your beasts will be very thankful that you have them.

I will now go to the last point, that is the comfort of the horse. I have told you about routine and feeding, etc. but there are lots of other little things which can add to his comfort. The greatest factor in a horses comfort is a man whose duties I think, as a rule, are worse performed than anybody's in the British Army, and that is the stableman. When you go down to the line and you shout "stableman", nine times out of ten he always appears from round the corner, and as likely as not he has been amusing himself dozing on a hay bale in the forage shed. When I tell you what a stableman's duties really are you will acknowledge he is a most important man. In the first place he ought to be a sentry, looking after his horses and watching them all the time during his tour of duty, for, mind you, he is in charge of valuable Government property and he may be the means of saving horses from severely damaging themselves, or getting loose and being lost altogether. He is of far more use and has greater responsibility than a sentry who only has to slap his rifle when saluting passing officers. The first thing he has to do is to see that all the animals in his charge are comfortable, that is that they can get up or lie down as they like and are not too

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crowded. Nothing pleases me more than to see animals on the lines lying down; I know they are resting and happy. Therefore he must see that all the head ropes are slack enough to enable the horses to lie down. Very often during stable hours if there is a fidgety or snappy animal who is ticklish when being groomed, the driver ties him up short to the tethering rope, forgets about him at feed time, and goes off, and he cannot lie down if he wants to. The stableman should see to that. He must prevent the horses from kicking, biting, and damaging each other and must always be ready to help them out of any difficulty. Horses constantly get hurt by getting their legs hung up on their chains or head-ropes. A stableman may be the means of saving you a very valuable horse. Unless that horse is helped quickly he might damage or wound himself very severely and have to be evacuated. Then if rugs are worn the stableman must see that all the horses get them and that they do not get on one side and slip off, but that they are put on right and kept right and the horses kept warm. He must see always that every animal at feeding time not only gets but finishes his feed; a stableman would in this way very often be the first man to find out that something is wrong with a horse. If a horse will not finish his feed the stableman should report it. The stableman is responsible that every horse gets his fair share of hay; if they are using hay nets, he must see that they are properly put on clear of the ground and high enough to prevent horses pawing them and getting hung up in the netting, also that greedy animals do not steal their neighbours ration. If there is any hay on the ground he must sweep it up and see that the horses get every possible bit they can. He must remove nosebags and hay-nets when empty before animals can damage them. He must also report any accident, and if a horse is bitten or kicked, he must let the veterinary sergeant know at once and have it treated. If any horses get loose and get away he must report it and have people to go after them and see that they do not wander and get lost if they stray out of the lines. And another thing, he must keep his lines clean. At present there is not half enough attention paid by stablemen to this point. I am not talking of stable hours but in the time between stable hours. He must not allow horse dung to lie where it falls. In closed stables it makes the air foul and smelly and is a great attraction for flies. Out at the Front in Summer time flies are a terrible nuisance—there are any amount of them and they worry the horses a great deal. Horses that stand constantly in dung are apt to get diseased frogs, they get what is known as "thrush", when the frogs rot and smell badly. If dung is left lying on the lines, horses sometimes contract the bad habit of eating it, which is very bad for them. All this collection of dung is very easily obviated by having at the end of each line a G.S. waggon or one of the limbered G.S. carts. The stableman must pick up the droppings directly they fall and take them off the lines and put them straight into the cart, and when the cart is full the fatigue horses on duty will take it right away to the manure heap allotted to your unit somewhere away from the lines, or to some farm where an arrangement has been made with the farmer to take the dung. Never have a dung heap or anything like a collection of dung on the lines.

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Then as regards lines. The usual thing for open air lines are long picketing posts and breast high tethering ropes. I prefer if possible, never to picket horses head to head on both sides of the same picket rope. If you have the breast high tethering rope, it is a good thing to have a second rope between that and the ground so that the horses can not get under it. By that means you can keep them on one side of the line during the day and shift them over to the other side during the night and give the day ground a chance of drying and having holes filled up. Horses when face to face fidget each other and always try to grab each others food and often snap and bite. If you are on uneven ground put your lines up and down hill. I will tell you the reason. Supposing there is a slope here (drawing on the blackboard) put your picket lines like that up and down the hill; by that means each aimal is standing more or less on a level. He will soon make his own little level place, so that he is standing evenly. If you have the lines this way along a contour the horse is not standing level—he cannot; he has got either his forelegs or his hind up or down hill, and if you have animals on both sides, the stale runs down hill from those above spoiling the standings and running into the hay of those on the lower side. If you can arrange a sand bath, your animals will appreciate a good daily roll, which is very good for them.

The last thing I shall say is a warning against the misuse of two things which are very much abused, and those are the whip and the twitch. As I have told you before, any animal rendered vicious or nervous by ill-usuage never does his best in an emergency, and you must teach your drivers that it does far more harm than good to overdo the use of the whip. They must teach the horse to work willingly and have confidence in them. The whip is only a guide, and the lash ought never to be used except in an emergency. You very often see ignorant men using the lash at every turn, spoiling their horses, making them unsteady and possibly timid and vicious. A very good way to tell whether your drivers misuse their whips and to teach them how to get the horses used to the whips is to get your unit out and make it file past you and then give "Eyes left" and if any horse or mule breaks out and shies into the ditch when the whip goes over you know that a bad use has been made of the whip by the driver. A horse can understand the whip, if he knows it is not to be used to punish him all the time. It used to be a beautiful sight in old days to see a good R.H.A. battery go from the trot to the canter and from the canter to the gallop without an arm being raised. All those pretty pictures you see in the papers of waving whips and drivers flogging for dear life are nonsense. A really good driver never uses the lash except in the last emergency.

The other thing I am warning you against is the twitch. It is much abused. Where men have not got the confidence of their animals and the animals will not let them handle them when shoeing, clipping, or even grooming, their only resort is the twitch. You must see if it has to be used, that it is a humane one. I have seen twitches made of whipcord, and screwed up so tight, that if the animal jerked or made any sudden struggle it would probably tear a good piece out

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of him. If you must use a twitch see that the loop is made of soft worsted or cotton rope, and sufficiently thick not to cut into the flesh if he jerks suddenly. But try and do without it. I have abolished it almost entirely among my own men. I have taught them to be gentle and to handle their animals well, and they have a good reputation now. An American General came round the other day and talked about mules. He said "Do you know out West we have a great respect for the mule. When he puts his ears back we know trouble is coming and he won't let himself be handled like a horse." I took him down to my unit and said "These are all American mules", and proceeded to pull their ears and tails, and the American General said to me "Well, Well, Well, you have "gentled" them some anyway" (Laughter). I think that is a very good illustration of the results of kind treatment. As I said before, encouragement is everything. Encourage your men to take a pride in their animals, and whenever you have a harness competition, which is a very good thing to have constantly, always give marks for the condition, and temper and training of the animals, whether horses or mules as well as the "turn out"—give the driver credit for the way he handles them and has brought them up, and you will find it pays in the end. The best driver will have the best groomed, best trained, and best mannered animals, and you cannot beat that. The only other thing is impress upon all officers, N.C.O's and men to *think of their animals all the time.* (Loud applause).

THE CHAIRMAN: Has any gentleman any question to ask.

COLONEL CLOETÉ: I should like to ask Colonel Hobday one thing. He mentioned the fact that he had got surplus nosebags. I did the same thing in 1915 and 1916, but I got into serious trouble with the A.Q.M.G. and very nearly lost my commission. I would like to know how he managed to do it.

COLONEL HOBDAY: I risked it, but I got them.

GENERAL ARBUTHNOT: I should like to refer to what Colonel Hobday said about loving your horses. I had a driver I took out with me to the Crimea who loved his horses and always looked well after them, so that when other horses in the battery were starving his horses were always sleek and fat; he always had picked up food for them somehow and we never had sick horses except on occasions when they were wounded. In those days, as you know, the field batteries had to take down the heavy guns to the trenches, and I was bringing my horses back one day, after having taken the guns down early in the morning, when a shell fell right in the middle between the leading pair of horses and this man, and all three tumbled over. I thought they were all three killed. However, driver and horses pulled themselves together and got up; we cut the horses out of the traces and brought them back to camp with us; although he was badly wounded he would not report himself sick, so that he might look after the horses. I got him put on to sick lines for that purpose and he brought those horses round thoroughly and they were perfectly sound again; and when we came home he brought the same pair of horses home in 1856 that were taken out in 1854. I doubt whether any other driver in the Artillery could say that. He was a

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fine specimen, as good a specimen of an artillery driver as one could possibly wish to have.

When I came to live at Woolwich 16 years ago he was then retired and was living with a married daughter down by the dockyard. He found me out and came up to see me and to talk about old times, and he recalled to my memory that story I have just told you about the wounded horses. If that man could do his duty in that way, so can other men do the same. That man loved his horses and his horses loved him, and I should like to see every driver in the Artillery if possible do the same and be as good with his horses as that man was with his. (Loud applause).

THE CHAIRMAN: I have not very much to say but I should like to emphasise one or two points.

With regard to the point Colonel Cloeté has raised, I agree with Colonel Hobday that it is a good thing to have as many nosebags as you can. Lots of people have done it and apparently they are still going on doing so.

I should like to emphasise what Colonel Hobday said about the stable man. I am quite certain that that is a point that is very much neglected. The stable man is put on duty there and, as Colonel Hobday says, when he is called for he is found sitting on something, and his job is not laid very great stress on of being a sentry.

Then I would emphasise another point—what he said about utilising the time of exercise, and I would also say the time going out to drill and the time coming back from drill, in teaching the men something or other. There was a little pamphlet issued by Sir Lawrence Parsons a long time ago, well written every page of it, which I would advise everybody to get and pay attention to. He laid great stress on this use of the time of exercise. I hope you will all bear it in mind—it interests us very much. Do not let the men lazy the whole time they are going there and the time they are coming back; you can teach them lots of things. And especially out on service, as Colonel Hobday says, you ought to know every highway and byeway—and not only you but the men too. One knows of heaps of cases where the officers themselves have not done it and have gone out of their way simply and solely because they have not utilised their time in this way.

I am sure you will all join me in a cordial vote of thanks to Colonel Hobday for his most interesting lecture; he has given us lots of hints and tips.((Loud applause).

COLONEL HOBDAY: Thank you very much, General Stokes and gentlemen for the way in which you have received the lecture I have given. It has been of great use they are kind enough to tell me to young officers and N.C.O's in the Artillery Schools in France where I have given it several times.

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RELATIVE

CALIBRATION BY THE CORRECTOR.

By Capt. B. M. G. Butterworth, m.c., R.G.A.

THE refinements which have come about in calculations regarding the "corrector of the moment" and the accuracy with which the corrector can be predicted, leads one to think that the bedrock from which these calculations are made can be reached by working backwards using the corrector as origin.

The present method of calibrating guns requires careful preparation, accurately surveyed points, and knowledge of the barometer temperature, and wind at the moment.

In the Siege Warfare now existing all the conditions can be fulfilled, but in open warfare the Battery Commanders only concern will be that his guns shoot alike, and he will engage his targets with the usual 600 or 300 yards bracket.

Experiments show that when a gun loses muzzle velocity a shortened corrector must be used in order to keep the bursts 15′ above the line of sight at all ranges.

The figures for the amount the corrector has to be shortened are:

For every 100 f.s. loss of M.V. at	2000 yards	19 points.
	3000 yards	17 points.
	4000 yards	15 points.
	5000 yards	13 points.
	6000 yards	11 points.

The following is a suggested method by which a Battery Commander can quickly discover how his guns shoot relatively to one another when fighting over open country which offers no well defined ranging points, or close country, where distant observation from close to the battery is impossible.

(1). Test sights.

(2). Select rounds with the same lot of fuzes.

(3). Decide on range at which to calibrate—say 4000 yards (no gun corrections will be applied).

(4). Raise Angle of Sight as expedient.

(5). Fire rounds of Battery fire—say from 8 to 12 rounds.

(6). Observe the height of burst of each round.

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Suppose such a series to be fired and the following observations made:—

Conditions:—

Barometer, Charge Temperature, Air Temperature } not known.
Wind-calm, velocity not known.
Angle of sight to crest 1°.
Angle of sight raised 2° above the crest.
Corrector: 150.
Range: 4000 yards.
Charge: Cordite.
Fuze: No. 80 Aluminium Lot. R.L. 6384.

Observations above the crest line.

Round.	No. 6 Gun.	No. 5 Gun.	No. 4 Gun.	No. 3 Gun.	No. 2 Gun.	No. 1 Gun.
1—6	2° 10′	2° 30′	2° 25′	2° 30′	2° 5′	2° 15′
7—12	2° 5′	2° 45′	2° 20′	2° 40′	2°	2° 10′
13—18	2° 5′	2° 50′	2° 45′	2° 50′	2° 5′	2° 15′
19—24	2° 20′	2° 25′	2° 40′	2° 20′	2° 20′	2° 25′
25—30	2° 30′	2° 40′	2° 35′	2° 40′	2° 25′	2° 45′
31—36	2° 10′	2° 35′	2° 50′	2° 10′	2° 15′	2° 15′
37—42	2° 45′	2° 55′	2° 30′	2°	2° 40′	2° 50′
43—48	1° 55′	3°	2° 55′	2° 50′	1° 50′	2° 5′
	18° 00′	21° 40′	21° 00′	20° 00′	17° 40′	19° 00′
Average	2° 15′	2° 42′.5	2° 37′.5	2° 30′	2° 12′.5	2° 22′.5

Now the gun with the greatest muzzle velocity will be that whose M.P.B. is highest—No. 5 gun in this case, No. 4 gun next, and so on, as tabulated below.

No. of Gun.	Mean pt. of burst above crest.	Angular diff. of MPB. from No. 5 gun.	Amnt. corr. must be shortened to bring MPB. up to ht. of No. 5 gun.	Loss of MV. compared to No. 5 gun.
5	2° 42′·5	—	—	—
4	2° 37′·5	5′	2·5 points	17 f.s.
3	2° 30′	12′·5	6·25 points	42 f.s.
1	2° 22′·5	20′	10 points	67 f.s.
6	2° 15′	27′	13·5 points	90¼ f.s.
2	2° 12′·5	30′	15 points	100 f.s.

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Treating No. 5 Gun as a standard gun the M.Vs. of the guns relative to one another are :—

No. 1	...	1548 f.s.
No. 2	...	1515 f.s.
No. 3	...	1573 f.s.
No. 4	...	1598 f.s.
No. 5	...	1615 f.s.
No. 6	...	1525 f.s.

and the necessary gun correction table for each gun can be made out.

Further if it is noticed that one of a battery of calibrated guns consistently requires a different corrector to the others it may be taken as an indication that the gun needs to be recalibrated, and its M.V. relative to another gun of the battery can be found as already explained in the course of ordinary shooting.

‡ At 4000 yards to raise M.P.B. 10 mins. requires the corrector to be shortened by 5 points.

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THE GUNNERS RULE.

BY SAGITTARIUS.

THE writer belongs, as will be gathered from his name, to the bow and arrow school of Gunnery.

Suffering himself from a constitutional inability to remember the multitude of formulæ which are in these days loaded into the brain of the Artillery Subaltern, he humbly offers the following suggestions in the hope that unfortunates like himself who cannot carry in their heads six-tenths rules, cosines, apex angles, and what not, may find them of the same assistance as he has himself done. He does not claim that they are in any way a discovery; but he suggests that the utility of the rule whose use he advocates is little known to the modern Junior Artillery Officer. The suggestions boil down to one, viz: Discard all rules that you cannot remember and pin your faith to the old, old rule—"The distance in inches divided by the number of hundreds of yards in the range, gives minutes deflection required." This rule in its simple form as given here is officially only recognised for finding the Angle of Sight and for calculating small errors in line.

The following examples show how it can be applied to solve other problems besides: and doubtless its use can be further extended.

1. The Battery is in position in a hollow, target is visible from a rise 100 yards in read: a convenient aiming point is a Church Spire on Right Flank, estimated range, or range taken roughly from the map, 2,000 yards.

With director at O find angle from Church Spire to T, say 110° Left. Then proceed

$$\frac{100^{\text{x}} \times 36}{20} = 180' = 3^{\circ}$$

Battery is in front of O, therefore Battery angle to T from Church Spire is $110 + 3 = 113^{\circ}$ Left.

2. F.O.O., after a successful attack is in an O.P. close to enemy's line: weather cover is Nil; O.P. and Battery Boards made by Survey Section are as yet non-existent: the ground can be recognised from the map, but for every reason it is undesirable to spread out a map and laboriously measure off angles with a protractor. A zero point has been decided upon, and guns have been registered for line on it. All that is now required is to draw a line on your map from Battery position through zero point and as far beyond it as is convenient, and fold your map so that your immediate zone and the line through the zero point are visible, the range to the zero point being known. The procedure when a target appears, is as follows:—

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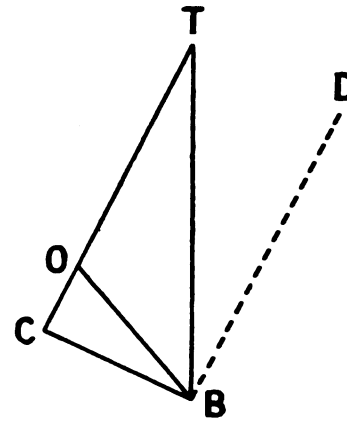
Measure on the map with the finger, or by any other convenient method, the perpendicular distance (P) between the zero line and the target, and by the same means measure the distance to the target beyond the zero point, from which B.T. can be found. Then (P x 36) divided by hundreds of yards in B.T. = minutes deflection required from zero line.

This method is of course not suitable for O.P's which are in the loving care of the Staff, and which are fitted up with everything which is useful and with a vast number of things which are not; but when the "O.P." consists of a ladder leaning against a wall, and the weather is of the variety which usually obtains during a British Offensive, to many temperaments it is less exasperating than is the process of struggling with a rain sodden map and a protractor on a muddy surface, in a gale of wind.



3. An ordinary T.O.B. problem without a plotter. Measure with director at O the angle T.O.B.: if the battery director lays out from director O the supplement of this angle it gets the line B.D. parallel to O.T. To obtain apex angle

(C.B. yds. x 36) divided by hundreds of yards in C.T. gives angle in minutes. Unless O.B. is very great the distance C.T. may be taken as equal to B.T., which can be measured on the map.

It is not claimed in any of the above examples that the method advocated is as accurate as the orthodox ones: it is of course slightly less so. But it is claimed that the errors consequent on its use are for practical purposes negligible, and can be corrected after the first round: and that it largely obviates the use of protractor and map boards which are often not available, and which are certainly a curse and not a blessing in an O.P. open to the weather, when the weather is bad. But above all only one formula has to be remembered. During more than two years active service in command of a battery and a brigade of R.F.A. the writer has met many subalterns who theoretically knew far better rules for solving such problems, but who in practice were helpless without the note-book in which they were written down: he has met few who could produce a quicker or more accurate solution than one worked out as described above. That it requires judgment in estimating distances is admitted, but it is submitted that it is an enormous advantage to have to remember one rule only, which gives sufficiently accurate results for all practical purposes.

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THE 'BEARING' METHOD OF LAYING FOR LINE.

BY TEMP. CAPT. L. A. NOTCUTT, M.C., R.G.A.

NOTE.—The author experimented with a variation of this method early in 1915 in France, but without the modification to the Dial sight as described hereunder, the method was not much improvement on normal methods. Several others have tried variations of this principle. The following article purposes to describe a combination of the best points in the several methods of which the author is aware.

IT is claimed that with the modification to a dial sight described hereunder, a simpler method of laying for line. The advantages claimed are:—

1. The line is measured from the map as a bearing, and without any arithmetic each gun can be layed on this line, using whatever aiming point has been selected as most suitable for each individual gun.

2. When the gun has been layed, the line ordered may be checked instantly by a method independent of the gun sights, without using any arithmetic.

3. At dusk, the sights are altered for the night aiming points, and the layer can use identical drill and figures for night laying as for day.

Wherever accurate maps are available—and with present appliances, in stationary or semi-stationary warfare, accurate maps are very rapidly prepared—the present methods of laying for line appear unnecessarily compilcated.

The method laid down in F.A.T. depend on the fact that each gun picks up the same aiming point, and all subsequent orders for line are given with reference to this aiming point. The method is not always practical in the field, because the same aiming point may not be visible to all the guns of the battery.

Therefore the zero line method has come into common practice, in which each gun may use its own aiming point, and each No. 1 must perform a simple arithmetical sum to determine the setting of his dial sight for any switch ordered right or left of the zero line.

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It is argued that this method is cumbersome, but is is undoubtedly the best one with existing equipment.

The method is cumbersome for the following reasons:—

(a). The No. 1 must perform an arithmetical sum in which it is possible for him to make a mistake.

(b). The Section-Commander, before he can check the line—if he desires to do so—must work out a different arithmetical sum for himself at each gun.

(c). No *simple* means of independently checking the line is possible.

(d). In order to calculate wind and clock code corrections, the battery officers must measure the line to the target as a bearing; and thus, when measuring the switch from the map, the officer must determine it, firstly, as so much right or left of the zero line, and secondly, as a true or grid bearing.

In this method, all lines of fire are measured and ordered as bearings. The bearing is set on the dial sights, and the gun layed on the individual aiming point for each sub-section, when the gun will be layed on the required line with the same degree of accuracy as with the zero line method.

The bearing can be used for determining wind corrections or clock code corrections, and by converting the bearing to magnetic bearing, the line of each gun can be very rapidly checked with prismatic compass, independently of the method of laying.

Use is made of the adjustable movement of the micrometer drums (the graduations on the left-hand micrometer head being obliterated) which can be set in any desired position.

The process of laying the original line of fire is then as follows:

The true bearing to the target is carefully measured from a map and noted (say this is 73° 25′).

The REVOLVABLE RING and DRUM are unclamped so as to rotate freely.

After the target has been carefully registered by each gun, the correction for wind is ordered to be set off on the deflection scale of the sight carrier, and the Nos. 1s ordered to select their permanent aiming points. Each dial sight is layed on to the aiming point selected, with the gun remaining on its registered line to the target, with the wind layed off on the deflection scale.

The Battery Commander then gives out the true bearing to the target (73° 25′). The Nos. 1s then rotate the REVOLVABLE RING to 73°, and the MICROMETER DRUM to 25′, so that the sights read the bearing ordered.

The Revolvable Ring and Drum are then clamped in this position by means of clamping screws.

NOTE.—'Grid' bearing may, of course, be substituted for 'true' bearing, if this is desired.

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The Battery Commander may then order any desired bearing and on setting this figure on the dial sight of the gun, and laying on to the selected aiming point for the particular sight, the gun will be accurately layed on the ordered bearing.

By ordering the breech to be opened, and the gun depressed, the line may be very rapidly checked by prismatic compass, to within a degree.

From the above description it will be seen that this method is extremely simple, each gun laying on its own aiming point with the bearing ordered by the B.C., without any calculations.

It is claimed that the above method is considerably more rapid, and less liable to mistakes, than the existing service methods.

Night Laying.

After the sights have been set for day laying, the night aiming post is planted. At dusk the operation of "Changing Aiming Point" is performed as follows.

The gun is layed for the night line from the day A.P. The Revolvable Ring and Drum are then set unclamped, and re-clamped, at the bearing for the night line.

As soon as the day A.P. becomes visible again, the above operation is reversed.

In order to check the setting of the dial sight, a point should be selected which can be sighted through the open sights, the bearing to this is measured, and the sights can at once be checked by laying the gun on the selected aiming point with open sights, laying the dial sight on the A.P., and checking that the bearings agree.

Description of Modification to a No. 7 Dial Sight.

Fig. I. shows a section of the dial sight, indicating the manner in which the ring is fixed.

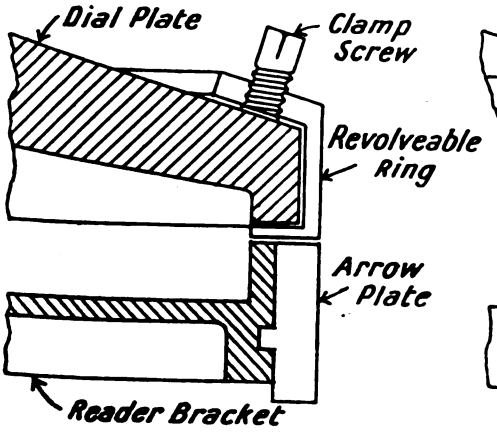

Fig. 1.

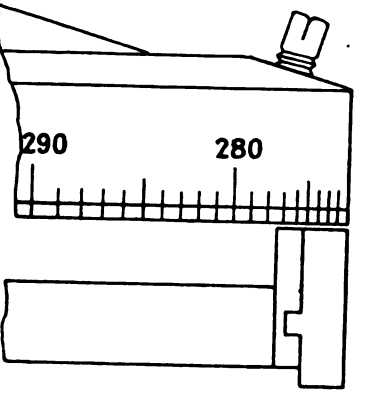

Fig. 2.

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Fig. II. shows a side view of this.

The ring is divided diametrically into two parts, as shown in Fig. III, which are screwed together on the dial sight to form a complete ring. As the diameter of the scale of angles is slightly larger than with a No. 7 dial sight, a new arrow plate is required.

There should be a combined key and tommy spanner (being the tools required to set the graduations of the sight) fixed to the sight by means of a chain.

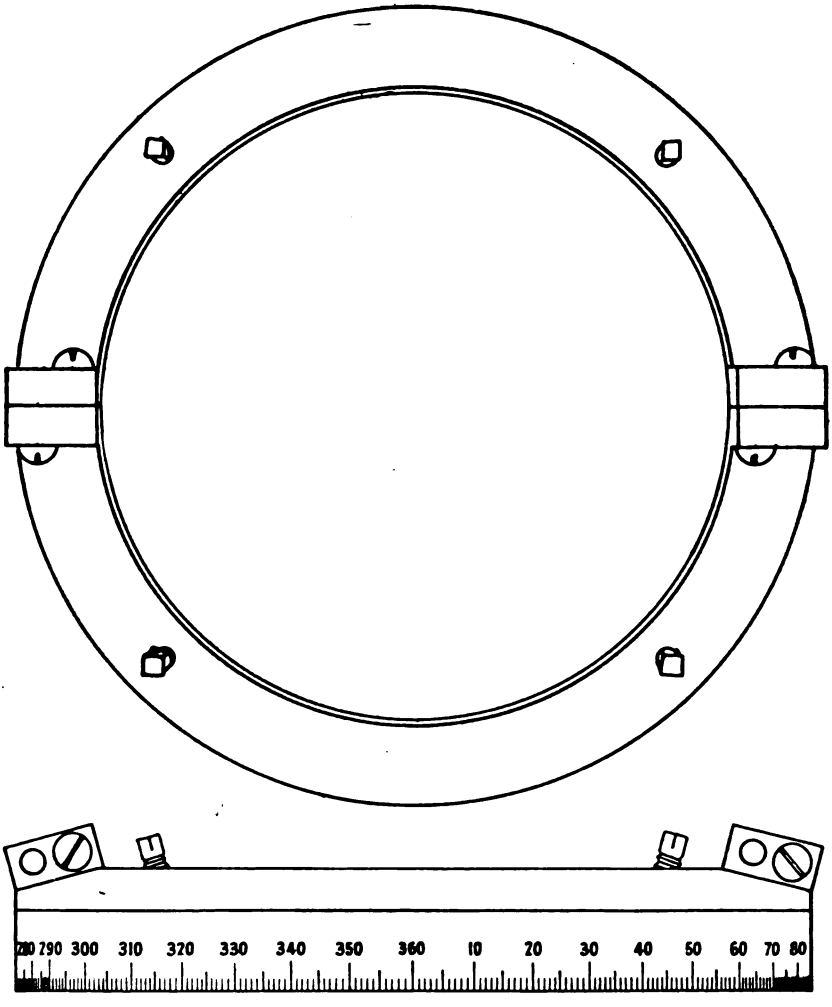

Fig. 3.

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LOCATING POSITIONS ON MAPS.

By Major J. Powrie, R.H.A., (H.A.C.).

THE problem of plotting one's exact position on a map appears to interest a large number of gunner officers and perhaps to puzzle a few. You will therefore perhaps pardon me when I refer to the note on "Resection of Position" in the January issue of the Journal. In the first place the three points should not, as stated, be as "far distant as possible", but on the contrary, the nearer they are, the more accurate the result, other conditions remaining unchanged. The author probably has gun aiming-points in mind which, as a rule, should be distant, so as to reduce parallax. Secondly, this method has already been described in detail in the Journal for January 1917, and thirdly, the method is a rather clumsy way of applying the two-circle principle practically.

In a note in the Journal for May 1917, I described a much simpler method of applying the principle, which I think is superior to the method referred to above and also to that given by Capt. R. C. S. Morrison-Scott, R.M. in the Journal for August 1917, although the latter is very neat and accurate. The advantages of the method I advocate are, among others—

1. The map is not spoiled by construction lines and compass holes.

2. No compass is required—only a protractor, pencil and piece of tracing paper (I used to save the unused parts of barrage and other tracings received from Group H. Qrs.)

3. Geometrical construction is extremely simple.

4. No table of sines, graduated scale or arithmetical calculations are required.

5. In practice it requires less than two-thirds the time required by the other methods to plot a point and, being simpler, is less liable to error. I say this after careful comparative tests. Those interested should certainly try the three methods with the same data and judge for themselves.

It may be of help to those searching for methods of fixing positions on maps to quote from the "Admiralty Manual of Navigation, 1914" (Price 3/-), which is now the standard work on this

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subject for the Navy and has been compiled from the best of the older works. In Chapter 8 it says, referring to cross compass bearings, "Objects should be selected that are near the ship, in preference to those far away, because any error in the bearing of a near object has less effect than the same error in the bearing of a distant object; moreover, as charts are slightly distorted in printing, long lines of bearing are never so accurate as short ones". Later in the same chapter we find, "Position by bearing and distance. When only one object is in sight, if we can obtain its distance, either by range-finder . . . . , and at the same time take its bearing, the position of the ship must be at the intersection of the line of bearing and the circle described with the object as centre and the distance as radius. This is an extremely useful method of fixing the position of the ship quickly". Of course, one need not actually draw the circle,

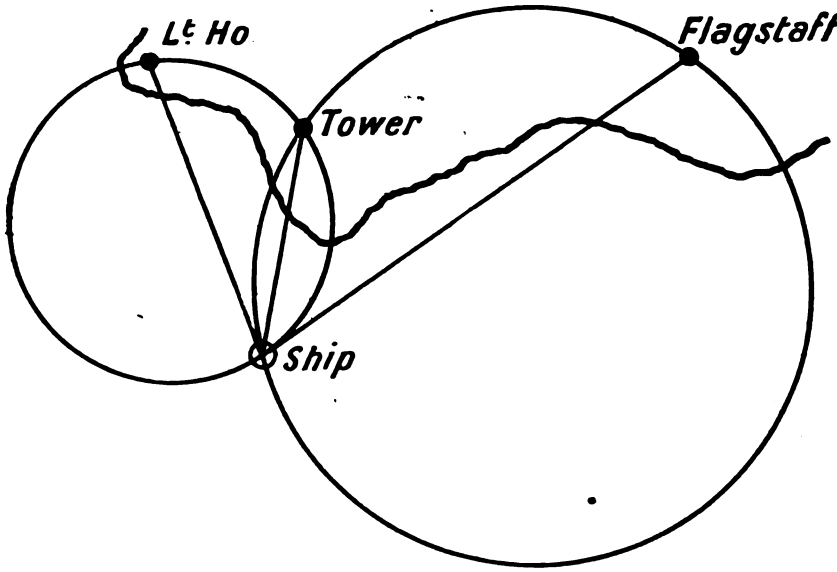

Fig. 53.

but merely measure off the distance with a scale along the line of bearing. I myself think that this is about the most useful all round method. Very often one can find something marked on the map within pacing distance (perhaps not in Palestine etc.) or the distance can be estimated nearly enough. If not, use the Barr and Stroud or sub-base method. The bearing can generally be found to within one degree and this only means a lateral error of about one sixtieth of the distance of the object whose distance has been paced etc. Plotting the result is quick and easy. Further on, after explaining the two-circle principle, we have "The drawing of circles is a matter which occupies time, and requires great care when accuracy is desired; but tracing paper on which the angles may be plotted or preferably the station-pointer, affords the means of ascertaining the

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position quickly, readily and accurately, provided that the angles of intersection of the circles are not less than 60°." In case the May 1917 Journal is not at hand, I may explain that the two angles observed are drawn on tracing paper, which is then placed on the map and moved about till the three points are each on their own straight line. The intersection of the three straight lines will then be on the required position. I find that the best way to do this is to get two of the points on to their own lines and then slowly turn the tracing paper, keeping these points on their lines all the time, till the third point comes on to its line. It is astonishing how quick one becomes after a few trials. In the same chapter the following useful advice is given. " It is important to select the three objects so that the circle through them does not pass through or near the position of the ship. By attending to the following rules this may be avoided.

(i). The middle object may be on the ship's side of the line joining the other two as shown in Fig. 53.

(ii). The three objects may be in or near a straight line as shown in Fig. 54. In this case the angles observed should not be less than, say 30°.

(iii). The ship may be inside the triangle formed by the three objects, as shown in Fig. 55.

In all doubtful cases, either a bearing should be taken of one of the objects, or a check angle taken to a fourth object. Where the distances, as shown on the chart, are very small, it frequently happens that the central part of the instrument obscures one or more of the points observed: in such a case it is convenient to plot the angles on

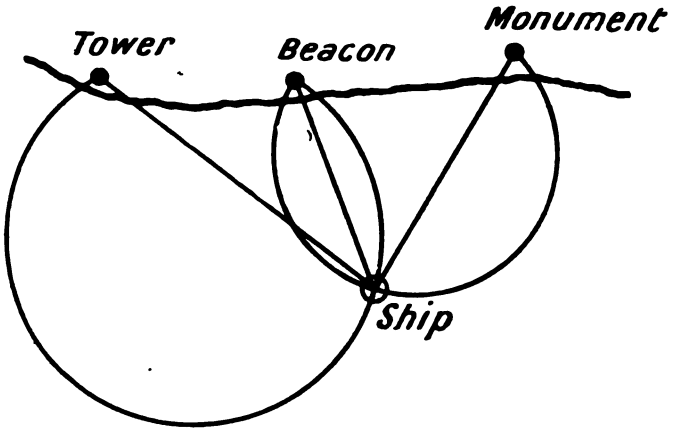

Fig. 54.

either a Douglas' protractor, a Cust's station-pointer, or a piece of tracing paper and to use it in the same manner as the station-pointer. The Douglas' protractor and Cust's station-pointer are graduated celluloid sheets on which lines may be drawn."

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If a piece of tracing linen be kept in the map case the pencil lines may be rubbed out each time and the linen used again, but it is never so transparent as good tracing paper. The great advantage of the two-circle principle is that it is free from the errors inherent in magnetic compasses. In iron ships and in the neighbourhood of guns, ferro-concrete shelters, masses of barbed wire etc. these errors

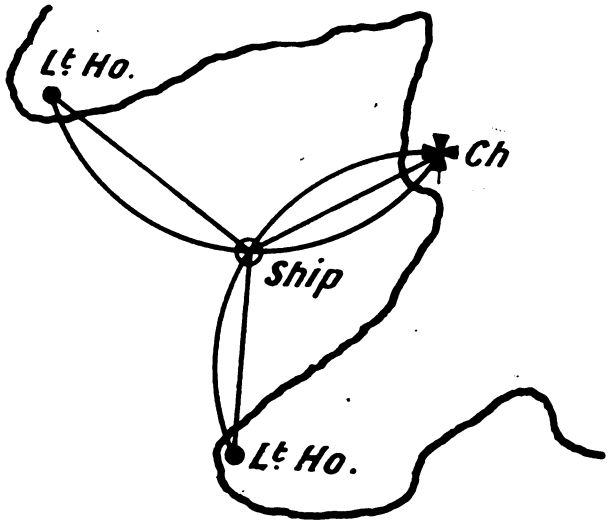

Fig. 55.

may be large and are difficult to determine accurately. If the accuracy of the maps is doubtful, try to use trigonometrical points fixed by the Field Survey Section or, failing that, fix the position from as many *independent* data as possible and try to infer the most likely position from the results. The station-pointer has been in use for over half a century, so it has stood the test of time.

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SURVEYS OF THE ENGLISH COAST

1779-1793.

From records of reports made by the Inspector of Royal Artillery on the Coast Defences of England.

BY MAJOR A. E. MACRAE, *pac.* R.A.

TO those who are interested in the history of our Coast Defences the following pages will be of the greatest interest.

The natures of the various guns and carriages used for defensive purposes, are clearly recorded, and a "reduction of armament" seems to be the chief object of some of the "Surveys".

It would appear that the "Care and Preservation" of gun carriages was of more importance than the storage and condition of the "Powder", or the state of the guns.

The reports on the personnel of the various batteries are most amusing, the "Master Gunner" being in most cases the "Principal Inhabitant of the Town".

Some of the batteries appear to have been more or less the special property of the particular towns and manned in case of "Alarm" by the inhabitants.

State of the several Batteries on the Coast of Kent, Sussex, Hampshire, Dorsetshire and Devonshire.

27th September 1779.

Dover:—

In the Castle the following Guns are Mounted.

24 Pounders ..... No. 10.
18 Pounders ..... No. 9.
12 Pounders ..... No. 14.

Two 18 Pounder Carriages and Two No. 12 Pounder Carriages are totally unserviceable, and most of the others want repair: The Bores of the Guns are much damaged from the want of Tampions: The Lieut.-Governor represented the Danger of the Weather Cock on the Tower, immediately over the Apartment where 1300 Barrels of Powder are deposited, as it might attract Lightning. Mr. Page was ordered to remove it. Eight Companies of the Oxfordshire Militia,

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and a Serjeant and 16 Men of the Royal Artillery are in Barracks there.

N.B. There are Two 18 Pr. Carriages in Store to replace the above unserviceable ones.

Arch Cliff Fort.—

The Battery, Guns and Carriages are in tolerable Order. A Company of Invalids are stationed there who occasionally assist in working the Guns.

Moats Bulwark:—

Seven 18 Pounder Guns and Carriages in bad Order: The Parapet Masonry is of very weak profil, and badly placed for the defence of the Beach.

First	Mounts	32 Pdrs. ... 7 18 Pdrs. ... 5	Guns, Carriages and Stores in perfect Order.
Second	,,	32 Pdrs. ... 3 18 Pdrs. ... 4	Guard Houses and Store.
Third	,,	32 Pdrs. ... 6 18 Pdrs. ... 3	Rooms wanting.

Folkstone:—

Six Nine Pounders on a Moderately high Cliff to the Westward of the Town. Guns and Carriages in tolerable Order but want some repair: Ten Barrels of Powder in the Magazine: Stores reported complete. One Master Gunner and one Quarter Gunner stationed here: The Town is very populous and would supply a number of useful hands for the service of the Guns.

Sandgate Castle:—

Ten 18 Pounders: the Battery in tolerable Order, but being of Masonry, and á Barbette, a Ship may easily approach near enough to silence the Guns. A Master and Nine Quarter Gunners are appointed here by the Lord Warden of the Cinque Ports.

Hythe:—

Six 18 Pounders. A Circular Battery constructed upon a small Mound of Earth, retired 600 Yards from High Water Mark; the intermediate Ground low Meadow, bounded by a Sea Bank which hides the Beach: A Thin Brick Parapet scarcely affords any Cover to the Guns and the Platform which is also paved with Brick is incapable of supporting their Weight. The Carriages are much decayed and the Guns damaged by Rust, about 19 Barrels of Powder in Store. There are stationed at this Battery one Master and Two Quarter Gunners, of whom (Alexr Carrs) being observed to be a Young and healthy Man he was ordered by the Master General to return to his Regimental Duty, and his place to be supplied by an Invalid.

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Rye :—

Twenty Four Pounders 10
Eighteen Pounders 4

The Platforms in very bad Order and the Carriages want repair. Two of the 18 Por. Carriages are totally unserviceable and the Guns belonging to them much damaged: This Battery stands upon a moderately high Cliff and Commands the Harbour at the distance of about a Mile from its Mouth. In the Town of Rye are Mounted Six old 4 & 3 Pounders Brass, which were presented to the Corporation by Queen Elizabeth: Their Carriages are quite decayed and the Guns seem very suspicious: In their present Situation they are entirely useless.

Hastings :—

Twelve Pounders—11, Mounted á Barbette upon the Sea Beach under the Charge of a Master and Two Quarter Gunners: The Guns, Carriages and Shot being much exposed to the Spray of the Sea, are exceedingly damaged by it. Tampions are wanted to the Guns. The Powder having been near 20 Years in Store, and one side of the Magazine being damp, Six Barrels have been rendered unserviceable and the remaining 14 Barrels are doubtful.

Seaford :—

Five 12 Pounders. Guns and Carriages are decayed by the Spray of the Sea, this Battery being upon the Beach, against which a Ship of Force may approach within half a Mile. The Guns lay low and are Mounted á Barbette. The Bay affords very good Anchorage. The Stores appear to be in good Order.

Blackington :—

Five 24 Pounders. The Parapet and Platform are in good Order and the Battery is very well constructed. The Guns, Carriages and Shot are damaged and Scaled by Rust, but are in tolerable Order. The Stores are reported Compleat and in good condition. One Master and Two Quarter Gunners are stationed here.

Newhaven :—

Eighteen Pounders No. 5. This Battery stands high and Commands the Entrance of the River Ouse which forms the West boundery of Seaford Bay: The Parapet is 18 feet thick of Sod and the Gun Carriages and Platforms are in very good Condition which is probably owing to their high situation, as the Battery was built when the others were. The Master Gunner Reports the Stores Complete and in good Order.

Brighthelmstone :—

Twenty four Pounders No. 12. The Parapet of this Battery is ten feet thick of Masonry, which with the Platforms are in tolerable good state. It is placed upon the Beach and nearly opposite the Centre of the Town: Centre of the Town: The Guns and Carriages have been lately Painted but are much damaged by the Spray: They

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may upon any sudden call be immediately Manned by the Neighbouring Inhabitants who are chiefly Fishermen and Seafaring People: There are 12 Barrels of Powder, besides twenty four filled Cartridges in Store at this Battery which amount to about eleven Rounds per Gun.

Arundel Haven:—

Eighteen Pounders No. 7. This battery Commands the entrance of the River Arun, is well constructed, and in good Condition, the Parapet sodded 18 feet thick and the Gorge stockaded. The Water on the Sea Beach shoals so gradually that the extent from high to low water Mark is nearly a Mile. Ships therefore cannot approach it except by the Channel of the River. The opposite Bank of the River afford shelter to an Enemy within Musket Shot.

The Guns, Carriages and Stores are in good Order and Compleat: Twenty four Barrels of Powder were received at this Battery last Year and twenty Barrels of the Old Powder now remains in Store there. Upon an emergency the Guns may be manned from the Crews of Ships and Vessels which lay at Little Hampton within half a Mile of the Spot.

Calshot Castle:—

Eighteen Pounders No. 9 }
Six Pounders No. 4 } The defences of this Castle are exceedingly out of Repair: The Gun Carriages quite rotten and many of them broken down under the Weight of the Guns: The Shot Ammunition and Stores of every kind are in the same defective and ruinous state: There are nine Barrels of Powder in the Magazine which is in the upper part of the Tower. This Place was surveyed about two Years ago but very little has since been done to it except the repairs of the Governors House. Ships of any force can approach within four hundred Yards of it at all times of the Tide, and if attacked, the Splinters of the round Tower of Masonry, which is only 10 Yards from the interior face of the Parapet, would render it impossible for Men to stand to the Guns, even if they were Capable of being fired: The Battery being Circular, not more than three Guns can be brought to bear upon an Object.

Hurst Castle:—

Eighteen Pounders No. 14 }
Six Pounders No. 8 } Is constructed on the same principle with that of Calshot, but is in much better Order all the lower Battery being casematted and the Masonry is very substantial: The Six Pounders were formerly Mounted on the Battlements of the Castle over the Casemates, but have been removed on account of the decay of the Platforms and Timber that supported the Roof. The Gun Carriages being under Cover are in general in tolerable Order, but need some repairs. There are five Barrels of Powder only in the Magazine and the Stores are decayed and incomplete. The Master Gunner Joseph Cox who formerly was a Serieant of the Guards and is grown infirm, requested the Master General's leave

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of absence on condition of his allowing one Shilling per Day to a substitute.

Thomas Powel one of the Quarter Gunners, who is quite incapable of any further Duty, having lost a Leg in the Service and is constantly lame of the other, also desired leave of absence. Some repairs were done at Hurst Castle this Summer by Colonel Archer.

Cowes Castle:—

Nine Pounders No. 10. This Battery is putting into a state of defence by General Monckton's directions: The Guns were new, Bushing and Carriages were ordered for them. A Corporal and Six of the Hampshire Militia Mount here. The Cistern is reported too small to supply Water to the Guard and Gunners; there is another Cistern in the Fort which wants repair. One Master Gunner and five Quarter Gunners are established here, Trattle being removed to Carisbrook makes a Vacancy. Willm Hayward who was taken from the 3rd Regt. of Guards has been a Cripple for upwards of 15 Years and incapable of any duty.

Carisbrook Castle:—

Is used at present as an Hospital. The Guns are all dismounted and their Carriages broken to pieces: The Establishment is one Master and one Quarter Gunner who are Inhabitants of Newport.

Sandown Fort:—

Nine Pounders No. 20. This Fort is a regular Square of one hundred Yards fortified with four Bastions and a wet Ditch; The Parapet of the Land Front is 18 feet thick and sodded. The Sea Front is Masonry of four feet, but there is room to thicken it inwards if necessary. Upon this Front ten Guns are mounted on the two Faces and Curtain and two Guns in the Flanks. A Detachment of the Isle of Weight Company with some Artificers from Portsmouth were employed in putting the Defences and Barracks in Order, and the Guns were Mounted upon New Sea Carriages. The Stores were reported Compleat and in good Condition. There are forty five Barrels of Powder besides fifty made up Cartridges. The Magazine which is the Centre of the East Curtain is exposed to the Line of Fire from the Sea and is not Bomb Proof. This Fort is Commanded from the Westward at 150 Yards distance. One Master and four Quarter Gunners are established here one of which is vacant by William Corbetts removal to Sheerness.

Yarmouth:—

Six Pounders No. 8 }
Nine Pounders No. 4 } These two Batteries are in tolerable Order and the Stores are reported Compleat: The Ordnance Establishment is one Master Gunner and four Quarter Gunners one of whom (John Pringle) has been long absent from his Duty but is Ordered to join. There is now a Vacancy of Quarter Gunner in the Room of Thomas France appointed Master Gunner.

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Portland Castle:—

Twelve Pounders No. 5 }
Eighteen Pounders No. 3 } was built in the Reign of Henry of the 8th. It is situated at the North end of the Peninsula of Portland and Commands the south part of Portland Road: The 12 Pounder Guns and Carriages which were in casematted Batteries are in pritty good Condition but want painting. The 18 Pounders are mounted á Barbette on an open Battery contiguous to the South Side of the Costle: The Guns are scaled and the Carriages decayed: There are 25 Rounds of Ammunition in Store, and five made up. The Master Gunner formerly belonged to the Royal Artillery, but the two Quarter Gunners are Natives of Portland who were recommended by the Town of Weymouth. They belong to the Quarries and lay at Night near the Castle. Portland Castle is situated immediately under a very high Hill.

September 1799. (Signed) Tho' Blomefield
Inspector Royal Arty:

To the Right Hon'ble & Hon'ble
The Master General & Principal Officers of His
Majesty's Ordnance

2

The present State the proposed Disposition of the Artillery and Stores in the several Forts and Batteries on the Norfolk and Suffolk Coasts, from Yarmouth to Languard Fort, agreeable to the Order of the Right Hon'ble the Master General.

Yarmouth District:—

The several Batteries Near Yarmouth extend nearly four Miles along the Sea Beach, and are placed opposite the different Channels, leading into Yarmouth Roads, and at the entrance of the Havens Mouth. They are situated in the following order.

Caistor Heights:—

At the Northern extremity of the Roads on Caistor Cliff Three 24 Pounders were mounted at the requisition of Lord Oxford under whose direction their Platforms were laid. There are neither Stores nor Ammunition with these Guns, and their Situation is entirely exposed. It is therefore proposed to withdraw them immediately to Yarmouth Lodge.

North Star Redoubt: Town Battery: South Star Redoubt:—

These three Redoubts extend along the Beach at the distance of about 1400 Yards from each other, and are constructed upon similar principles: They are fraised and their Gorges are closed with Stockades, and Blockhouses sufficiently capacious to be converted into useful Store-houses. It is proposed to dismount all the Guns in

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these Redoubts excepting one in each; and to lodge all their Stores and Shot in the lower Story of the Blockhouse. The Guns to be skidded under Cover of the Parapet, and their Carriages stacked in the upper story of the Blockhouse, leaving sufficient space for any small Guards that may occasionally mount in them. A Small Magazine to be left in each Redoubt for Six Rounds of Ammunition and the Stores of the Guns which remain Mounted.

The Old Fort:—

At the Havens Mouth has been strengthened by an Advanced Redoubt and Blockhouse: The Fort contains no other Buildings than Apartments for the Master Gunner and two Quarter Gunners, and a Magazine in which are 212 Barrels of Powder: It is in an exceeding Bad State, the Weather dripping thro' it in many places: This is the only permanent Magazine for the supply of the Works. It is proposed to leave one 32 Pounder Mounted in the advanced Redoubt and one 24 Pounder on each of the Circular Batteries in the Old Fort and to lodge the Stores and Carriages of the remainder in the Blockhouse of the advanced Redoubt, and the Storehouse at Yarmouth.

Gorleston Hill:—

Upon a Commanding Cliff to the southward of the Old Fort there is a Battery of Six 24 Pounders. There is a small Store-house in this Battery in which a Labourer resides who takes care of it. As this Battery has an extensive Command it is proposed to leave one Gun Mounted and withdraw the remainder to the Havens Mouth.

In the Town of Yarmouth there is a Storehouse and Shed which is hired by the Ordnance at the Rate of 28£ per Annum, and is engaged till Michs: 1784 and contains 30,000 Sand Bags, which are reported to be in a perishable State, and cannot be wanted.

There being an established Shorekeeper at Yarmouth, it may be expected that the Preservation of the Stores will be duly attended to, but as they will be dispersed in the several detached Works, it will be absolutely necessary for their security as well as that of the Works themselves, that a sufficient Garrison should be kept at Yarmouth to furnish a Centry for each of these Works. At present the Troops Quartered at that place consist of one Troop of Light Dragoons, and about 40 Men of the Ninth Regiment of Infantry.

Lowestoff:—

To the Northward of the Town of Lowestoff, there are two Batteries, one on the Beach of four 32 Pounders, and two 9 Pounders, and the other about 400 Yards in the rear of it upon a Cliff of four 18 pounders. They are both Stockaded, and the lower one has a Blockhouse, which will contain the Carriages and Stores of both, in which it is proposed to deposit them, excepting one Gun to remain Mounted on the lower Battery.

Lowestoff District:—

To the Southward of the Town is an inclosed Work Mounting ten 32 Pounders and Three 18 Pounders: It contains a very hand-

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some substantial Guard House and Store Room. There is also a Magazine capable of containing of about 700 Barrels of Powder but being covered in too suddenly is so extremely damp, that there is every reason to suppose that upwards of 300 Barrels of Powder which are now in it, either are or will shortly be entirely spoiled, unless instantly removed. Some filled Cartridges which are placed there, are as wet as if they had been exposed to a Heavy Deu. It must be therefore be considered as entirely useless till some means are used to render it dry. The Store Room may be considerably enlarged with little trouble or expence by partitioning off part of the Mens Guard Room, and would furnish Space enough for all the Stores and Carriages on the Batteries. It is proposed to leave two 32 Pounders Mounted in the Sea Front and One 18 Pounder towards the South approach and to dismount all the rest.

Corporal Purney of Major Woods Company has been left with the Charge of the Stores, as there is no Ordnance Establishment whatsoever at this place, and the Storekeeper at Yarmouth does not consider it as within his District: Should the Master General and Hon'ble Board consider these Works of sufficient importance for the Charge of a Master Gunner, the Guard Room would afford Him a Comfortable Residence.

Parkefield Battery:—

About a Mile to the Southward of Lowestoff upon the Height of Pakefield is a stockaded Battery of Four 32 Pounders with a Small Storehouse. It Commands the Southern Entrance of the Yarmouth Roads, but is so detached, that it would be advisable to withdraw the Guns and Stores to Lowestoff, as the whole Coast is so infested with Smugglers, that unless sufficient Guards could be kept, they would be continually liable to their depredations.

Landguard Fort & Harwich District:—

At Landguard Fort there are 115 Pieces of Artillery Mounted on the defences of this Fort; the whole of which with their Carriages, appear to be in very good order.

It is proposed to leave the following Number Mounted Viz:—

In the Princess Lines — One 9 Pounder		Defences toward the Land.
Kings Lines	1st Battery, one 42 Pounder 5 Battery, one 9 Pounder	
Rainham Redoubt North Front.	2 — 9 Pounders	
Rainham Redoubt Southfront	- 1 42 Pounder	Defences towards the Sea and the Channel leading to the Harbour.
Bow Battery	- 1 9 do	
South Barbette Battery	- 3 42 do	
North Barbette Battery	- 1 18 do	
Southflank of Beauclerks Batty.	- 2 42 do	
On the Ramparts of the Fort towards the Harbour.	- 23 6 do	for a Saluting Battery.

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The remainder of the Guns to be skidded on their respective Works and their Carriages stacked in the Passages round the different Guard Houses, which are very convenient for that purpose, and where they will be perfectly dry and secure: It is proposed to Pile the Shot in two temporary Shed Guard Houses, which are not put to any use. There are in the Fort and Lines, four excellent Magazines, Viz:—

Two	capable of	containing	together	1042 Barrels.
One	do	do	230	do
One	do	do	162	do
			Total	1434

There is a considerable quantity of Storehouse Room in the Fort, and if necessary it might be considerably encreased, by applying the New Guard House to that use.

Harwich Battery:—

Four Nine Pounders are Mounted on a Stockaded Battery South of the Town of Harwich which are not essential to the defence of the Harbour, and as there is neither Storehouse nor Magazine on it, it is proposed to lodge the Guns and Carriages in Languard Fort.

The Platforms on all the Works are new and in excellent Order. Those on the Yarmouth and Lowestoff Districts are of Fir, but those of Languard Fort of Oak Plank. It were much to be wished that some means were used for their Preservation.

(Signed) Tho' Blomefield

September 1779 Inspr. Royal Arty.

To the Right Hon'ble and Hon'ble The Master General &
Principal Officers of His Majesty's Ordnance.

3

Report of the State of the Artillery and Store Houses at Plymouth and its Dependencies, September 1st 1783.

Plymouth Castle:—

On the Defences of the Citadel there are 95 Pieces of Artillery 32, 24, 18, 9 6 and 4 Pounders, of which it is proposed to leave the following Number Mounted: The remainder to be dismounted, the Guns skidded on the Batteries, and their Carriages Housed which are

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in tolerable order, many of them having been lately repaired and others New.

For a Saluting Battery extending from The Flag Battery to the Salient Angle of Charles Bastion	—	9	Pounders	No. 22
In Ligoniers Battery towards the Sound	—	32	Pounders	No. 4
In Catherines Bastion towards the Town	—	6	Pounders	No. 2
In the Flank of - do -	—	6	,,	1
Prince Rpers Bastion — Right Face	—	6	,,	1
Prince Rpers Bastion — Left ,,	—	6	,,	1
Prince Rpers Bastion — Flank	—	6	,,	1
			Total	32

There are several Spacious Casemates in the Citadel, but all too damp for the Reception of the Garrison Carriages of the dismounted Guns: It is therefore proposed to erect an Airy Shed for that purpose in the Gorge of Prince Henry's Bastion. All the Sea Service Guns and Carriages which were mounted in the Citadel during the Alarm in the Year 1782, are to be removed to the Gun Warf and Stacked there. There is an exceeding good Store House in the Cidadel, the upper story of which is proposed to contain the Barrack Stores, Musquets and Accoutrements, and the lower story, part of the Field Train, and their proportion of Stores, as also the Gunner's Stores belonging to the Citadel.

The Shot of the Garrison may be Piled in two store Cellers which are tolerably dry and Airy.

Plymouth Lines:—

There are three Store Houses in the Lines. The North Store House near Marlbro Bastion and Shed at the East end, which is in the occupation of the Barrack Contractors.

The South Store House which has no Shed, but in other respects is similar to the North Storehouse. The Ground Floor of these two Storehouses to receive the Carriages and dismounted Guns of such part of the Field as is not contained in the Storehouse in the Citadel. In their upper Stories are to be stowed their Ammunition, Small Stores and Harness etc. Some stantions are wanted to support tthe upper Floors.

The Center Store House near Granby Bastion will serve very conveniently for the reception of the remainder of the Ammunition and Stores belonging to the Field Train, being very dry and Roomy: It is at present occupied by the Barrack Contractors Bedding which might be deposited with equal convenience in two or three Spare Barrack Rooms.

The Barrack Stores in the shed of the North Store House is also in the Barrack Contractors possession, which might contain several of the Garrison Carriages from the Neighbouring Works.

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The Powder, Match, and Stores for those Guns which remain mounted may be deposited in the three Small Magazines in the Ravelins, the Cavalier and Mount Poise.

There are 153 Pieces of Ordnance Mounted on the Lines of Plymouth Dock, and Redoubts and the Batteries on the Heights of Maker and Staten.

The following Pieces are proposed to be left Mounted.

Toward the Land Approach—

On the Eastern Face of Western King Commanding the Channel into Hamoaze ...	18	Pors	No. 6
On the Cavalier Battery	12	,,	2
On Granby's Bastion	12	,,	1
On the Barrier Battery	9	,,	1
On the Marlbro' Bastion	9	,,	1

The remainder of the pieces to be dismounted. The Sea Service Guns and Carriages to be taken to the Gun Wharf, and the Land Service Carriages to be Stowed in the Sheds in the North Store House, in two other Sheds which are proposed to be erected for that purpose against the Back parts of the Centre and south Store Houses, and in the store Rooms on Wester King, and Mount, and in an Old House which may be converted to that use near Passage Point.

The Block House and Magazine at Mount Pleasant will receive the Carriages and Stores belonging to the Ordnance in that Redoubt.

St. Nicholas Island:—

On the Works of Saint Nicholas Island are Mounted Twenty three 32 Pounders, Six 18 pounders and Two Brass 13 inch Mortars, of which it is proposed to leave Mounted.

On the Half Moon Battery,	32 Pounders	No. 3	}	Commanding the sound and passage to Hamoaze.
On Western Battery	32 do	2		

There are two Small Magazines lately constructed here, which will contain all the Stores and Shot, and a small shed may be erected between them for the Carriages of the dismounted Guns.

All the 32 Pounders and many Guns of other Natures on the Works of Plymouth and its Dependencies are exceeding old, and will on examination be probably found unserviceable.

The Carriages are either New or have been lately repaired, but in general want Painting, which it would be unadvisable to do till next Summer, as they will then be perfectly dry. The Guns in general also want Painting, but it may also be defered till they all have been re-examined and the unserviceable Guns are rejected, which may be done in the course of next Summer.

Plymouth and its Dependencies:—

During the Alarm in the Summer of 1782, a great Number of Sea Service Guns and Carriages were Mounted on the several Works

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about Plymouth, which it is proposed to return into Store at the Gun Wharf, and a Set of Serviceable Guns and Carriages of such Natures as shall be judged best adapted to the defences, to be appropiated to the different Batteries with their proportion of Stores and Shot, which may be lodged in the Sheds in readiness for their being immediately Mounted when necessary.

Plymouth Gun Wharf:—

The Gun Wharf at Plymouth is much too confined for the present increased State of our Naval Stores, but may Conveniently be enlarged by taking in ground to the Northward, which belongs to the Government.

The Storehouses are also insufficient in their present state for Housing the Carriages and Stores, which are landed from the Ships Ordinary in this Port, amounting to 29 Ships of the Line, one 50 Gun Ship, 8 Frigates and 3 Sloops.

As the Sea Service Carriages are exposed to the Weather, the following disposition is proposed for their security.

There are four Carriage Sheds already Constructed in the Gun Wharf, mostly filled with Stores, great part of a perishable Nature, or unserviceable Nature, or unserviceable; by removing which and covering in a Shed adjoining to the present North Carriage Sheds, sufficient Room will be made for nearly all the Carriages.

The Stores which at present incumber these Sheds, and other Store Houses, it is proposed to dispose of as follows.

All the perishable and Unserviceable Stores and Carriages to be immediately shipped for the Tower or Sold. The Match, Cordage, Grape Shot, Wads and other dry Stores, to be lodged in the Grand and Small Magazines and Cooperages, which are at present intirely empty, and afford a great deal of Stowage.

The Passages round the Magazines may Conveniently hold Coals or such other Stores as are not liable to injury from damp.

These expedients are only proposed till the intended two new Store Houses are erected; one of which is for the Field Train: It may then be advisable to remove the Small Magazines intirely, which now encumber the Wharf very much.

A Shot Yard is much wanted at Plymouth Gun Wharf, the Foundation being so bad where the Shot are now placed, that the piles are giving way: A convenient situation for that purpose may be chosen at the Northern extremity of the Gun Wharf, some other spot may possibly be found in a Rocky Soil and that expence saved.

There are at present many unappropiated Guns at Plymouth, which it would be advisable to remove from thence, as they will serve to replace those, which will probably be condemned, when a General examination shall be made of the Sea and Land Service Guns.

It is proper to observe that the detachment of the Royal Regiment of Artillery at Plymouth are so extremely Weak, as scarcely to afford twelve Men fit for Duty: It will therefore be necessary to procure Working Parties from the Garrison, or hire Lobourers to execute these Duties.

The Commanding Officer in the Lines having hitherto been particularly attached to the Field Train the Stores belonging to it

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were placed under His Charge; but it is now submitted to the Hon'ble Board, whether it would not be proper to deliver them over to the Storekeeper.

There are Fourteen large Mantelets Mounted on Carriages at Plymouth, which are already injured by the Weather, and being excessively expensive in their Construction, should be sent up to be put in order by the Maker, otherwise they will in a Short time be intirely spoiled.

(Signed) Thos. Blomefield
Inspr. Royl. Arty.

Woolwich,
30 September, 1783.

To the Right Hon'ble & Hon'ble the Master General, and Principal Officers of His Majesty's Ordnance.

4

The following Directions for the Principal Officers of the Ordnance at Plymouth, are humbly submitted to the Master General & Hon'ble Board.

To Principal Officers at Plymouth:—

To furnish any assistance that shall be required by the Commanding Officer of Artillery, for placing the Guns and Stores in the Garrison and Works of Plymouth in a state of security.

To make a strict survey of the Shot, Carriages and Stores, rejecting such as are unserviceable, and directing those which are repairable, to be put in a Serviceable State.

To make an arrangement and disposition of the Stores at the Gun Wharf, agreeable to the Inspectors Reports.

To take under their Charge the Field Train and proportion of Stores belonging to the Western District

To collect all the Camp Equipage, and such other stores as are of a perishable Nature, and do not form a part of the Garrison proportion, and send them with the unserviceable Stores to the Tower.

To Order proper Vessels as soon as possible to bring away the Ordnance and Stores from Torbey, excepting those on Fishcombe Battery; also the Powder and Unserviceable Guns and Carriages from Dartmouth, and the Camp Equipage, and Unserviceable Stores from Falmouth.

To collect all the Arms and Accoutrements which were issued to the Inhabitants upon the Alarm of an Invasion.

To send up to Woolwich the unserviceable Guns only—all the unappropriated Serviceable Guns are to remain there to replace those which will be Condemned upon a General Examination.

That none of the Carriages be Painted, till after having lain in Store a sufficient time to be perfectly dry.

To send up to Woolwich by the first opportunity all the Mantelets both Mounted and Unmounted.

To transport to the Gun Wharf all the Sea Service Guns and Carriages which are mounted on the several Works, in order that a

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New Set may be appropriated of such Calibres as shall be judged best adapted to the several defences.

To stack all the filled Cartridges with Barrels except 20 Rounds for each Gun remaining Mounted on the Works.

To Commanding Officer of Artillery.

To direct the arrangement and disposition of the Guns, Carriages and Stores in the Garrison and Works of Plymouth, and the Western District agreeable to the Inspectors Report, and have them stowed in the most secure and Compact manner.

To procure Working Parties from the Troops, and hire Labourers, Horses etc. for this purpose, applying to the respective officers at the Gun Wharf, for any assistance that can be afforded from thence.

To deliver over into Storekeepers Charge the Field Train and proportion of Stores belonging to it, reserving what may be wanted for the Exercise and Practise of the Detachment of the Royal Artillery.

To keep 20 Rounds of filled Cartridges and a portion of Stores for the Guns which remain Mounted on the Works in readiness to be immediately issued when wanted.

When the strength of the Detachment will afford it to mount an Artillery Guard on Western King, and at other times to have a careful Non-Commissioned Officer on Duty there, with the Charge of the Mounted Guns and Stores in the Lines.

To the Commanding Engineer.

To construct dry and Airy Sheds, as recommended by the Inspector of Artillery for the reception of the Carriages and Stores in the Plymouth District.

To allot two or three Spare Barrack Rooms for the stores belonging to the Barrack Contractor, in order to make room for Carriages, Ammunition and Stores belonging to the Field Train.

To Consider and report upon to the Board the most effectual means of preserving the Wood Platforms on the Works; calculating the original expence of the Materials, and Workmanship, and the expence that would attend their removal and Stowage in a place of security.

To Report upon the means of enlarging the Gun Wharf at Plymouth, and the choise of a proper spot for a Shot Yard, and whether the Ground to be taken would afford a good foundation for the purpose without Piling. Also to transmit the Plans and Estimates of the intended new Storehouse ot the Gun Wharf.

To give the necessary Orders for carrying into execution as soon as possible, the proposed arrangement of the Carriages and Stores on the different Forts and Batteries on the Western Coast, conformably to the Inspector of Artillery's Report which is transmitted to the Respective Officers of Ordnance at Plymouth.

(Signed) Tho' Blomefield

Inspector of Royal Artillery.

To the Right Hon'ble & Hon'ble the Master General and Principal Officers of His Majesty's Ordnance.

(To be continued).

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"BRAIN RE RULE OF THUMB".

(A Reply),

By Major A. E. C. Myers, R.G.A.

IN the R.A. Journal of October 1917, an article appeared entitled "Machines *v* Head", advocating a gunner being able to solve any simple problem in the field in his head without the use of the various gadgets and machines which had been coming unofficially into use. This article has been somewhat severely criticised in the February number in an article called "Brain *v* rule of thumb", but which should have been called "Slide rule *v* rule of thumb", as the author advocates the slide rule for solving all problems.

Now a slide rule expert can solve almost any problem very quickly and accurately, but to use the slide rule well, a good deal of knowledge and constant practice are required. In the hands of a man who is not good at it, it is a dangerous instrument and a source of error. The writer of the "Brain *v* rule of thumb" article himself admits this, as he states that a man uses the rule of thumb "in order to avoid the use of an instrument which he is probably incapable of comprehending." This appears an excellent reason for not using it.

In any case, as, owing to the present short period of training, the slide rule is not, or has not been, taught to the large majority of gunner officers, the article seems beyond the point.

Finally, the slide rule expert may lose his slide rule and unless this makes him lose his head too, he ought still to be capable of carrying on by means of some simple formula or rules of thumb.

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PRÈCIS OF
REVUE MILITAIRE SUISSE.

February, 1918.

The present situation of our infantry machine gun sections.

A technical article on the organization and training of the machine gun sections of the Swiss Army. Contains a summary of the lessons drawn from the present war with regard to the use of machine guns.

The Italion Theatre of Operations (continued).

Continuation of previous articles by Col. Fontallaz, Swiss Attaché to the Italian Army. The present article deals with the geographical features influencing the Austro-German operations which brought about the retreat to the Piave.

Military music in the Swiss Army.

Of local interest only.

Divisional Machine-Gun Groups and their importance.

Organization and mobility. Their value to the Division. Examples of their employment in advanced guard actions. Choice of men and officers.

The Goose-Step.

A strong plea for the abolition of the "goose-step" (pas eadencé) in the Swiss Army, except for drill and physical training purposes.

A War Museum of Anatomy.

An article on the Inter-Allied Museum of Anatomy set up in London under the œgis of the Royal College of Surgeons, and the benefits to be derived from it in the cause of humanity.

Swiss Chronicle.

Portuguese Chronicle.

An article showing the reasons why Portugal entered the War in Europe and a rough account of her military contribution on the Western Front.

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Telegrams: "UBIQUE, Woolwich." Telephone: "371, Woolwich."

Contents of R.A. Journal, June, 1918.

Surveys of the English Coast 1779-1793. From records of reports made by the Inspector of Royal Artillery on the Coast Defences of England. By Major A. E. Macrae, *p.s.*, R.A., continued from page 86. 89

Calculations necessary for the Construction of Dug-outs and Gun Pits. By Temp. Major F. M. G. DuPlat-Taylor, R.G.A. 107

Notes on the Identification of Points. By Capt. K. F. W. Dunn, R.F.A. 117

"Flying".—An Explanation 120

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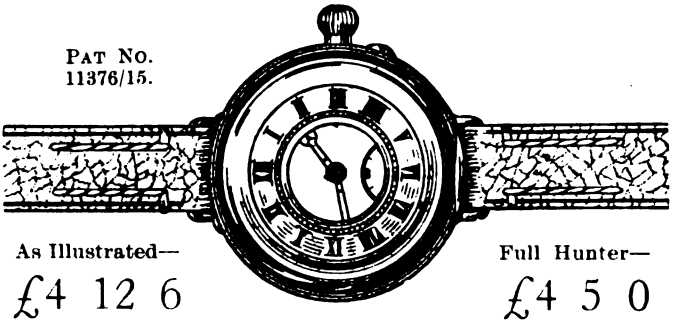

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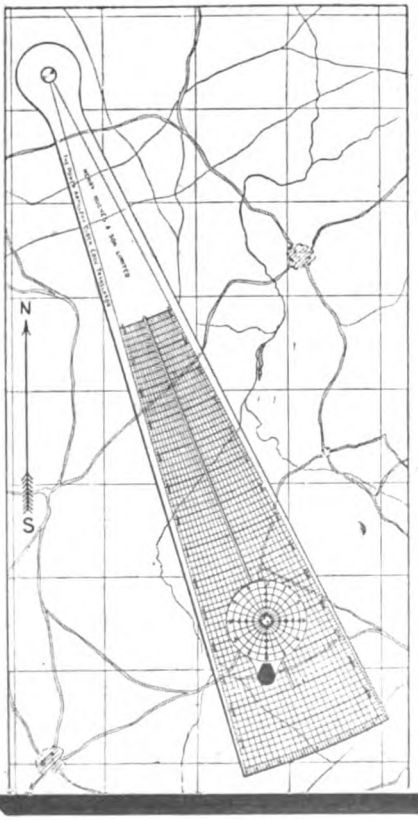

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SURVEYS OF THE ENGLISH COAST 1779-1793.

From records of reports made by the Inspector of Royal Artillery on the Coast Defences of England.

(Continued from Page 86).

BY MAJOR A. E. MACRAE, *pac.* R.A.

5

Report of the State of the Artillery and Storehouses at Falmouth and its Dependencies.

Pendennis Castle:—

There are Fifty five Pieces of Iron Ordnance Mounted at Pendennis Castle, of which the following Number are proposed to be left Mounted, and the remainder, Skidded on the Batteries and their Carriages, Housed.

On the Half Moon Barbette Battery Commanding the Sea Approach	18 Pors ...	No. 3
On the South West Bastion Commanding the Beach on Gillans Bay	9 Pors ...	1
On the Flank of -do- on Gillans Bay	9 Pors ...	1
On the North face of the North Bastion towards the Harbour	9 Pors ...	1

There is a Storehouse on Crab Key Battery which will contain all the Carriages of the Guns belonging to it, and a part of those of the Half Moon Battery immediately above it.

The Ground Floor of the Storehouse in the Castle will nearly contain the remaining Carriages by removing the Stores at present there into two Spare Barrack Rooms.

The Upper Floor will contain all the Stores in the Store-keepers Charge; It is at present encumbered with a quantity of Camp Equipage which was received from Plymouth, and from the Herefordshire, Militia: Part of it is unserviceable, and the remainder in a perishable State.

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Saint Maws Castle:—

The 9 Pounder Guns are in general Old, but the 18 and 24 Pors New Guns. Both Guns and Carriages want Painting which may be done after having been examined.

Is situated close to the Channel which leads into the Harbour, and has a Half Moon Battery of Six 6 Pounders and Six 24 Pounders. All the Guns are old excepting one 24 Pounder. The Carriages all appear Sound, but want Painting. In the Castle there is a great deal of dry Store House Room both below and above.

The Carriages of the dismounted Guns may be Stowed in the Guard Room.

It is proposed to leave two 24 Pounders and one Six Pounder on each Flank Mounted.

The Platforms here as well as at Pendennis are of Stone. One Invalid Gunner resides in the Castle. The Master Gunner is the Principal Inhabitant of the Town and lives in His own House.

Mevagisey:—

Upon a Cliff to the Northward of the Harbour of Mevagisey is an enclosed Battery of Six 18 Pors, which as well as the Carriages want Painting. This Battery and the Store House in its Rear, was erected at the expence of the Town: A Principal Inhabitant Mr. Saml. Ball assured me in the Name of the People of the Town that they would erect Sheds in the Battery at their own expence for Housing the Carriages and Paint Both the Guns and Carriages.

Fowey:—

The Channel leading into the Harbour, is defended by three Batteries on the West side, which are constructed at the expence of the Inhabitants.

That at the Mouth of the Harbour Mounts	18	Pors	...	No. 2
	12	,,	...	No. 2
	6	,,	...	No. 1
The Second Battery	12	,,	...	3
The Third Battery	9	,,	...	2

The 2nd and 3rd Batterys have Sheds which will contain all the Carriages; and the Tower above the entrance has been repaired to receive the Stores and Ammunition. The Guns and Carriages appear to be in Want of Painting but in Serviceable Condition.

It is proposed to leave one 12 Pounder and one Six Pounder Mounted at the entrance of the Harbour, and to dismount the remainder, Skidding the Guns and Stacking the Carriages in the Sheds of the 2d and 3d Batteries.

The Mayor of Fowey has promised that this shall be done by the Inhabitants, and that it shall be reported to the Hon'ble Board when executed.

There is no Gunner, nor any Person in a Military Department here to take charge of either the Guns, Ammunition or Stores.

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Looe:—

There are 14 long 6 Pounders Mounted at Looe, Ten of which are in front of the Town, on the Beach, and 4 on a Height to the Eastward of the Entrance. The Guns and Carriages want Painting. These Guns were sent at the requisition of Mr. Butler the Member, and the Mayor proposes to have the Carriages secured in some Shed in the Town: The Batteries here were constructed by the Inhabitants.

One Six Pounder is proposed to be left Mounted on the high Battery Commanding the entrance of the Bay.

Dartmouth Castle:—

There are upon the lower Battery at Dartmouth Castle Six 12 Pounders, and upon the upper Battery Six 6 Pounders. The Guns are very Old, and appear to be unserviceable, and the Carriages are quite Rotten.

There are also Six old 3 Pounders mounted here, which were used to Bring Ships too, to collect Port Duties.

Last Christmas there were 10-18 Pounders sent here for an intended New Battery. Both them and the Carriages want Painting.

It is proposed to remove the Old Guns and Carriages to Plymouth, except two of the 3 Pounders, and to Mount two of the New 18 Pounders on the lower Battery. The remainder of the New Guns to be dismounted and Skidded and their Carriages Housed in Sheds which must be built for that purpose against the Wall in the rear of the lower Battery.

The Magazine in this Castle is a very dangerous and in convenient One, it being under the Building in which the Master and Quarter Gunner resides, and is no otherwise secured than by a Common Trap Door, which opens from a Store Room with Iron Hinges, Staples etc: There is therefore no possibility of Shifting or Airing it, without the greatest risk and inconvenience. In high Tides the Sea frequently washes in at the Air holes.

There are no less than 136 Barrels of Powder in the Castle, which is sixteen more than this Magazine can contain: The remaining Barrels are placed in the Store Room, and secured only with Tanned Hides. It is of the utmost consequence that the Powder should be removed to Plymouth immediately, leaving five Barrels for the use of the Fort.

The Master Gunner represents His having built a Shed at His own expence for the security of the Fire Engine which was sent down, and which cost about £16. He requests that the Hon'ble Board will please Order Him to be reimbursed that expence.

Torbay:—

The Road to Torbay is defended by Four Batteries, extending from the Berry Head, along the Cliff to the Town of Brixham.

The 1st Mounts	14 - 20	Pounders.
	2 - 8	inch Howitzers.
The 2nd „	3 - 20	pounders.
The 3rd „	3 - 20	pounders.
„ 4th of	5 - 20	Pounders is on

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Fishcombe Point, to the Northward of the Town of Brixham. This Battery is inclosed with a Small Storehouse in its rear, in which Serjt Walker of Captn Manley's Company, resides, who has Charge of the Stores.

The three Batterys on Bury Head are á Barbette and not inclosed.

There are no Sheds here for the reception of the Carriages; and the Storehouses and Magazine are merely temporary Buildings.

The Storehouses are full of Land Service Stores and there are near 50 Barrels of Powder in the Magazine. The Platforms are all of Fir.

As the Carriages and Guns appear to be in good Order, it is recommended to remove both them and the Stores to Plymouth, as also the Platforms, and the Materials with which the Storehouses, Magazines, and Guard Houses are Constructed.

The Battery of Fishcombe Point, is situated near the Town, and has the means of securing a proportion of Stores and the dismounted Carriages in the Store House, it is proposed, therefore to leave the Guns belonging to it under the Charge of some of the Principal Inhabitants dismounting them all excepting one, and Housing the Carriages.

A Serjeants Guard of Hanoverians Mounts upon the Batteries at Berry Head, which are furnished from Brixham.

(Signed) Tho' Blomefield

Inspector of Royl Artillery.

To the Right Hon'ble & Hon'ble the Master General and Principal Officers of His Majesty's Ordnance.

6

Report of the State and proposed disposition of the Ordnance in the Portland and Poole Districts.

12th October 1783.

Weymouth:—

There are mounted on the Beach and the Heights near the Town of Weymouth the following Pieces of Ordnance, which are claimed by the Corporation as having been purchased by the People of the Town: The Guns are extremely Old and Unserviceable, and their Carriages decayed.

On A Saluting Battery on the Beach ...	9	Pors ...	No. 2
	6	,, ...	No. 1
	3	,, ...	No. 5
On the Heights above the Town	9	Pors ...	No. 3
	6	,, ...	No. 1

The Corporation also lay claim to two dismounted Guns 9 Pounders which formerly belonged to a Ship that was Wrecked on the Coast: They are also unserviceable.

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Portland Castle:—

In Portland Castle, there is a casemated Battery of five 12 Pounders, which have been Mounted there 37 Years, but having been under Cover, the Carriages appear to be still Serviceable.

On the Eastern Side of the Castle is a Battery á Barbette of three 18 Pounders, the Carriages of which are totally Rotten: The Guns are also very Old, and will probably be found unserviceable when properly examined.

No repairs having been done to the Castle for 30 Years past the Roof admits the Water in several places, and the Timber in some places much decayed: The firing of these Guns on the usual Festivals breaks the Windows and shakes the Building very much for which reason it would be advisable to discontinue that practice.

There is a small dry Magazine and Store Room at the Top of the Castle and much vacant space in the lower apartments and in the Offices.

On the different parts of the Cliff in the Island of Portland there are mounted 12—18 Pounders and Six 6 Pounders, which have been lately sent there: The Guns may be Skidded under shelter in the Court Yard.

Mr. Steward the late Mayor of Weymouth, has promised that this shall be done by the Inhabitants of Portland, and will charge himself with the execution of it.

Swanage:—

At Peverel Point, near the Town of Swanage are Mounted Seven 9 Pounders á Barbette, which were supplied at the requisition of the Inhabitants, and have been of considerable use in protecting the Trade bound to Poole; an Appartment for a Gunner and His Stores has been erected on the Battery, but is rather too Confined for receiving the Carriages. Some of the Principal Inhabitants who were applied to, seem indisposed to be at any further trouble or expence in securing their Pieces, it would be therefore advisable to remove them, unless the Corporation of Poole should take some measures for their security.

The Guns and Carriages are serviceable but want Painting.

Poole:—

In the District of Poole the following Pieces are Mounted.

On the Cliff at North Foreland	9 Pors ...	No. 4
The Bottom of Studland Bay	6 Pors ...	No. 4
South Haven Point	9 Pors ...	No. 3
Browsey Island	9 Pors ...	No. 5
	6 Pors ...	No. 2

The Guns and Carriages are serviceable but Need Painting.

The Mayor of Poole promises to have the Carriages Housed and the Guns secured at the expence of the Town, which is to be signified to the Board Officially, after having communicated His proposal to the Corporation. He has also undertaken to recommend the same measures to be pursued at Swanage.

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Near the Seat of Mr. John Pitts, about 5 Miles to the Westward of Swanage there are two 12 Pounders Mounted on a Cliff. That Gentleman will probably take upon Him to secure the Carriages, which will save the trouble and expence of their removal.

(Signed) Tho' Blomefield
Inspr. of Arty.

Right Hon'ble & Hon'ble the Master General and Board of Ordnance.

7

Report of the State of the Artillery and Store Houses in the Thames and Medway Districts.

Gravesend Block House:—

The advanced Work at New Tavern has no Guns Mounted on it, but there are Seventeen New Oaken Platforms laid. It is proposed to take up the Platforms entire, excepting two near the Northern Salient angle, upon which two 32 Pounders are to be Mounted, bearing upon the Reach of the River.

In the interior Work there are mounted

42 Pounders
32 Pounders
ditto

Of these two 32 Pounders are to be left, and one 9 Pounder to bring Ships to occasionally. The Platforms here are mostly too Old to be taken up without great injury: It is therefore proposed to caulk and coat them with some Composition which will preserve them from the Weather, if upon Trial it is found unadviseable to remove them.

The Carriages appear Sound and in good Order as well as the Guns.

In the Rear of this Battery there is a spacious Brick Building, which has hitherto been used as a Stable to the Governors House (now in the occupation of the Storekeeper): As a much smaller Building would answer this purpose, it is proposed to erect one in the most convenient situation and convert this Building into a Storehouse. It would then afford Space to House the Carriages, Platforms, Shot and other Stores belonging to the Several Batteries on this side of the River.

Tilbury Fort:—

The Guns mounted on the Different Works of Tilbury Fort are.

42 Pounders No. 27
32 Pounders No. 6
9 Pounders No. 33 Total 66

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Of these it is proposed to leave a Sufficient Number Mounted to form a Saluting Battery on the Eastern and Western Gun Lines of Twenty two Nine pounders, all the rest of the Guns to be dismounted. The Guns Skidded on their Batteries, and the carriages Housed in a Shed, which may be built for that purpose against the South Bastions, there being no proper place for them in the Fort.

The Platforms are all of Stone excepting those on the Eastern Gun Line, which are of Oak but too old to be easily removed, and may be caulked in the same manner as those on the other side of of the river.

Chatham Gun Wharf:—

The Sea Service Carriages belonging to the Ships in Ordinary at this Port to the Number of about 2000 are at present exposed to the open Air, but if not immediately Housed must sustain great injury, as most of them want Painting.

There is a very spacious Carriage Shed consisting of 23 Bays, which are capable of containing about 4000 Carriages: Part of this Shed is occupied by Pontoons and Entrenching Tools, but when properly Arranged sufficient Space will be found for all the Carriages.

The Store Room at this Gun Wharf is very considerable, but encumbered with unserviceable Stores which if removed would afford abundant room for all the Ordnance Stores now here.

The Storekeeper requests that a discretionary power may be allowed Him to send up to the Tower occasionally: The present established Rule He says is to send them in once a Year only.

There is also a restriction from taking up additional Labourers on an emergency, but seeing the absolute necessity of housing the Carriages as soon as possible the Storekeeper upon any representation, took upon Him to engage some additional hands for this duty, which He hopes the Board will not disapprove of.

There being no Carpenters Shop in this Gun Wharf the end of the Carriage Shed is used for this purpose: A Work Shop might be very conveniently placed against the South Wall of the Gun Wharf and much room would be gained by it, for the Stowage of the Carriages.

Chatham Lines:—

There are 94: 9 Pounders and one 6 Pounder Mounted on the Lines, which as well as the Carriages are in good Order.

There will only be left Mounted a Saluting Battery of 23: 9 Pounders on the Southern extremity of the Lines á Barbette.

The Platforms are of Oak and are to be taken up and Preserved in Store.

There being no Storehouse in the Lines, there is one proposed to be built; in the lower part of which the Carriages are to be stowed; and in the mean time they may be Housed at the Gun Wharf.

Gillingham Fort:—

This Battery is entirely in ruins except the Gunners Apartments which have been repaired.

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There are Fourteen 32 Pounders Mounted on two low Batteries which are unserviceable and should be immediately removed to Woolwich, as also the Powder to Upnor Castle. There are 52 Barrels in Store. The Magazine is tolerably dry but wants repair. There is one Master Gunner and Two Quarter Gunners stationed here.

Upnor Castle:—

Is at present used only as a Magazine. There are however 11 very Old 9 Pounders let into a frame of Wood to fire on rejoicing Days. They are very dangerous Guns a man having been actually killed in attempting to reload one of them when His Majesty was at Chatham. It is therefore proposed to remove them entirely, as the Neighbourhood is so large a Magazine is certainly a very improper situation for any Battery. There is an Establishment here of one Master Gunner and 12 Quarter Gunners, but four only attend.

Hooness:—

A Situation on the Medway where a Master Gunner is stationed but has no Guns Mounted.

Cockham Wood Fort:—

Another dismantled Battery where a Master Gunner is fixed but no Guns Mounted.

As Lowestoff, Fowey, Penzance and some other situations on the Coast, where Works have been lately established, are without Master Gunners or any other Person Charged with the Stores, it is suggested to the Hon'ble Board to remove these People, from very Aguish and unhealthy situations, where they have no Duty to others where they may be useful provided it shall not be thought expedient to restore these Batteries.

Sheerness:—

The following natures of Guns are proposed to be left Mounted on the Works in Sheerness.

On the face of Minster Bastion	42 Pors ...	No. 2
Flank of Queenboro Bastion	18 Pors ...	No. 1
No. 1 Battery ..... Gunners Grand Battery ..... Flank to Craigs Battery	for Salutes 9 Pors ...	22

The remainder of the Guns to be dismounted and Skidded, and the Carriages to be disposed as follows.

Those of the Half Moon Battery to a Shed erected in the Battery. The remainder in a Store House in the Storekeepers Yard.

Many of the Platforms are of Wood and not very new, having received some injury by Moisture. It is proposed to examine some of them and if it appears that the sleepers and many of the Planks are worth preserving they will be taken up, otherwise suffered to remain after having caulked and coated them with some Composition to resist the wet.

There is a great deal of Room in dry Casemates for Stores, Planks etc.

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Gun Wharf:—

There being few Ships in Ordinary at Sheerness there are but few Sea Service Carriages there.

The Carriage Sheds is fully sufficient to contain those which are there and they will soon be Housed in it. The Foreign Guns and Carriages are to be sent along with the unserviceable Guns and Stores to Woolwich the first Opportunity.

(Signed) Tho' Blomefield
Inspr of Royl Arty.

To the Rt Hon'ble & Hon'ble the Master General & Board of Ordnance.

8

November 12th 1783.

Report of the State and proposed disposition of the Ordnance and Carriages of Tinmouth.

Tinmouth:—

There are Forty five Iron Ordnance Mounted on the Defences of Tinmouth Harbour, on the North side of the River Tine..

Cliffords Fort	18 Pors - 19 9 Pors - 8	The Guns old and much Scaled with Rust, Seven of the 18 Pounder Carriages much decayed the rest in good order.
Castle Battery	18 Pors - 7	
Spanish Battery	18 Pors - 11	Guns and Carriages Good but want Painting.

The Guns on Cliffords Fort and Castle Battery were Proved and Searched in January 1783, by Order of the Master General and Hon'ble Board. In this Proof one 18 Pounder and 1 9 Por burst, and from Captn Brady's Report it appeared that of the remaining Pieces which stood the Proof, Six 18 Pounders, and Six 9 Pounders were condemnable for Deep and dangerous Holes, which Guns still remain Mounted.

They will therefore be retained for further service after Condemning the above.

18 Pounders 20
9 Pounders 2

Of these Guns are Mounted at Cliffords Fort

18 Pounders 13
9 Pounders 2

And on Castle Battery

18 Pounders 7

The Shot of all the Batteries have been long exposed to the Weather, and are in general in a very bad State.

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The following dispositions proposed to be made of the Guns and Carriages.

There is a very Spacious and dry Store House in the Castle, which is intended for a Field Train, and in which there will be sufficient room to stow away all the Carriages and any other Stores that might be found Serviceable. The Carriages on the Spanish Battery are intended to be placed in an airy Store House in that Battery, as soon as the fixed Ammunition which is now there shall be removed to a proper place.

All the Platforms at Tinmouth are of Stone.

The Field Train at Tinmouth consists of the following Pieces.

Medium	12 Pors - 2	These Pieces being all Mounted in the Store House, it is proposed to dismount them excepting 6 Light 6 Pors and 2 Royal Howitrs and to stack the Carriages and Ammunition Wagons.
Desagrs.	6 Pors - 4	
Sight	6 Pors -16	
	3 Pors - 2	
Howitrs.	8 inch - 2	
	5½ inch - 2	

There are four New Batteries erected at Tinmouth, but no Guns as yet have been allotted to them.

(Signed) Tho' Blomefield
Inspr of Arty.

To the Right Hon'ble the Master General and Board of Ordnance.

9

Report of the State and proposed disposition of the Ordnance and Carriages at Hull and Lynn Regis.

12th Novr. 1783.

Hull:—

There are Mounted in the Garrison and Town of Hull the following Ordnance.

Garrison	18 Pors No. 15	Of this Number 8: 18 Pors and 8: 9 Pors and 4: 3 Pounders were sent here in 1779 and are in good Order, but all the rest are Old and will mostly be found Unserviceable.
	9 Pors 12	
	3 Pors 20	
Town	18 Pors 6	
	9 Pors 1	

The Carriages are all in good Order, having been either replaced or repaired very lately.

Twenty Nine of the Platforms are of Oaken Plank, and the remainder of Stone.

In the Garrison are two old ruinous Block Houses which afford considerable space for Stores and also a spacious Train Shed which is very dry and Airy.

The following Brass and Iron Mortars are in Store here Viz:—

Iron Mortars	13 inch - 2	without Beds.
Brass Mortars	5½ inch - 4	Mounted and have been here upwards of 30 Years.
	4 2/5 inch - 10	

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There are considerable quantities of Unserviceable Shot and Shells here.

It is proposed to leave the following Guns Mounted in the Garrison.

3 Pors 20 - on the Saluting Battery.

9 Pors
- 1 - at East Saliant Angle.
- 1 - on the South Curtain.
- 1 - on the face of the West Bastion.
- 1 - on the west Saliant Angle en Barbette

N.B. The oldest Guns and Worst Carriages to remain Mounted.

All the Dismounted Guns and Carriages to be Housed in the Train Shed excepting those in the Artillery Yard Battery which being casemated, they will be sufficiently sheltered where they stand.

The Wood Platforms to be carefully taken up except those in the Artillery Yard Battery which being casemated they will be sufficiently sheltered where they stand

The Wood Platforms to be carefully taken up excepting those necessary for the Mounted Guns and lodged in the Train Shed.

The Brass Royals and Cohorns to be sent to Woolwich when a convenient opportunity shall Offer for that purpose.

It is necessary to mention that the Apartment now used as a Magazine is an old ruinous Blockhouse and in a very alarming State, the Beams above it being incapable of Sustaining the Weight of the Roof and of late have settled considerably.

There are about 100 Barrels of Powder in this Magazine and a great Number of Musket Ball Cartridges.

Lynn Regis:—

There are ten 18 Pounders mounted on the Side of the River, rather as a Saluting Battery than for the defence of the Town, their being neither Parapet nor Platform.

The Guns are Old but in tolerable good State: The Carriages are very sound and fresh but want Painting much. They were sent thither in May 1780.

The Shot and Stores are lodged in a dry and secure Storehouse near the Guns and are in good Order; but there is no convenient shed for the Carriages near the Spot.

The present Mayor (Mr. Case) being absent, the Chamberlain of the Town has received Instructions concerning the proposed disposition of them, who will lay it before the Mayor on his return, and endeavor to provide some secure Shed for the Carriages or erect one at the end of the Storehouse, which affords a very convenient situation for the purpose.

(Signed) Tho' Blomefield
Inspr. of Royl. Arty.

The Board of Ordnance.

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10

Report of the Batteries on the Coasts of Kent and Sussex.

13th December 1783.

Margate:—

On the Pier are Mounted	18 Pors	No. 2
On the Cliff at the entrance of the Town. ...	18 Pors	4
	24 Pors	4

The Guns and Carriages are in good Order and have been lately Painted.

There is a dry Store House on the Pier containing the Shot and Stores.

The whole is under the Charge of the Inhabitants.

Mr. Cobb the Senior Warden of the Port engages on the Part of the Inhabitants that, the Guns which are now Mounted on the Cliff shall be dismounted, their Carriages Stowed in a Dry and Airy Shed and the Guns skidded on their Platforms.

That the two Guns which are on the Pier, are to remain Mounted there for occasional purposes.

That the Shot are to be piled in the Storehouse and the Ordnance Stores kept dry and in good Order.

That no time shall be lost in carrying this into execution.

Broadstairs:—

Three Miles to the Southward of Margate, there are four 12 Pounders Mounted on the Cliff to the Northward of a Small Rocky Bay.

The Guns and Carriages are in good Order.

The Shot and Stores are in a Store Room belonging to Mr. Gore the Principal Inhabitant.

It is proposed to remove these Guns and Stores to Dover; the Situation being of too little consequence to render a permanent establishment necessary.

Ramsgate:—

There are eight 9 Pounders mounted on different Points about the Harbour. The Guns are Old, but the Carriages Sound and good.

The Shot and Stores are lodged on a Cavern in the Chalk Cliff, which is not sufficiently secure, nor dry for that purpose, nor can a convenient place be procured.

It is therefore proposed to remove the Carriages and Stores to Dover, and leave the Guns here skidded and Tampeoned.

Sandown Castle:—

There are Nine 9 Pounders Mounted on Old and decayed Carriages, the preservation of which are not worth attending to, and as they may serve some Years longer in this State, it is not proposed to be at any trouble or expence with them at Present.

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Deal Castle:—

Nine Pounders 11: The Guns have been long here, but the Carriages are Sound and in good Condition having been lately sent here: It is proposed to dismount the Guns and House the New Carriages in a dry Store Room in the Castle, and as the Old Carriages which remain in the Castle will answer every purpose of Salutes etc. during the Piece the Guns are to be again Mounted on them.

There are 50 Barrels of Powder here a considerable part of which is unserviceable.

The Window of the Magazine is very dangerous and insecure.

Walmer Castle:—

There are Eighteen 9 Pounders Mounted here Thirteen of which are on New Carriages.

The Store Room being exceeding damp it is proposed to House the New Carriages in the Store Room at Deal Castle: The Stores which are now here should be immediately removed into a dryer Situation: The five old carriages to remain Mounted.

Dover:—

The following Ordnance are mounted here

On the Works of the Castle.	32	Pors - No.	6
	24	,, -	10
	18	,, -	9
	12	,, -	7
	6	,, -	1
Moats Bulwark.	32	Pors - No.	6
	18	,, -	10
	10	Inch Howitzers	1
Norths Battery.	32	Pors - No.	6
	18	,, -	6
	10	Inch Howitzers	1
Amherst Battery	32	Pors - No.	3
	18	,, -	6
	10	Inch Howitzers	1
Townshend Battery	32	Pors - No.	6
	18	,, -	3
	10	Inch Howitzers	1
Arch Cliff Fort.	32	Pors - No.	6
	18	,, -	7
	10	Inch Howitzers	1

On the New Advanced Works 12 Pors - 6

Abstract

32 Pors - No.	33
24 ,, -	10
18 ,, -	41
6 ,, -	1
Howitzers 10 inch	5
Total	90

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All the 24 Pounder Carriages and Seven of the 12 Pounder Carriages are damaged. The remaining Ordnance and Carriages are in exceeding good Order. The following Guns are proposed to be left Mounted.

For Salutes	At the Castle ... 16 Moats Bulwark ... 3 Arch Cliff Fort ... 3	Those Carriages which are most decayed to be left.	
For occasional defence.	North Battery ... 1 Amherst do. ... 1 Townshend do. ... 1	18 Pors.	

The Carriages of the dismounted Guns to be disposed of as follows.

Those at the Castle to be Housed in a Dry Store Room there. Those at Arch Cliff Fort, in empty Barrack Rooms. Those in Redoubts and New Works in the Ground Floor of the Naval Storehouse. The dismounted Guns to be Skidded on their respective Batteries, and Moveable Sheds to be constructed for Sheltering the New Carriages of the Guns which remain mounted.

The Shot to be piled in the Storehouses on the several Batteries and the filled Cartridges stacked into Barrels.

There are a great number of live 10 inch Shells here which should be emptied by Careful Artillery Men, who may be sent for that purpose.

Folkstone:—

On the Cliff are Mounted en Barbette Six 9 Pounders on old Carriages: There are Six New Carriages which have been sent down to replace them.

It is proposed to erect a Small Shed against the Gnnners House for the New Carriages, and dismount all the Guns from the Old Carriages excepting two. The Guns to be Skidded.

A New Flag Staff was sent down here Three Years ago which is decaying on the Ground and should be painted and fixed.

The Palisades in the rear of the Battery are much out of Repair.

Sandgate Castle:—

Ten 18 Pounders. The Guns are Old and much exposed to the Spray, the Carriages are sound and good: A Shed is proposed to be constructed in the Most Sheltered Situation for containing Nine of these Carriages, and Six New 18 Pors from Hythe, which may easily be removed there, the distance being about a Mile only.

Hythe:—

Six 18 Pounders. The Guns and Carriages are in exceeding good Order. The Guns are to be Skidded and the Carriages removed to Sandgate Castle.

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Rye:—

24 Pors No. 10
18 Pors 2
} These Guns are in good Order.

The 18 Pounder Carriages are Sound, but all the 24 Pounders Carriages Old and damaged, but may serve some Years. It is scarcely worth wile to erect a Shed for their reception, but dismount all the Guns but two, and House the Carriages in the Church adjoining which is Roomy and dry.

The Magazine in this Battery is very damp, and has no less than seventy Barrels of Powder in it, most of which will probably be found unserviceable.

A considerable quantity of Palisades are piled in the Battery, which were deposited here when the Camps were formed in the Neighbourhood.

Hastings:—

Eleven 12 Pounders. The Carriages New and Sound, and the Guns in good Order. The Palisades in the rear of the Gunners House are out of repair: and there is neither Shed nor Storehouse on the Battery.

It is proposed to construct One, for ten of the dismounted Guns.

There are seventy five Barrels of Powder in a Small Magazine where there is neither room for Airing or Shifting it. The Shot on this, and on all the Batteries on the Coast are covered with moveable Sheds.

(Incomplete)

x x x x x x x x x x

(Signed) Tho' Blomefield
Inspr. of Royl. Arty.

To the Right Hon'ble and Hon'ble the Master General & Board of Ordnance.

11

Surveyed in the Year 1785.

Chatham Lines	9 Pounders	76	13	5	94
	6 Pounders	—	—	1	1
Gillingham Fort.	32 Pounders	—	—	14	14
Upnor Castle.	No Guns here at the time of the Survey in the Year 1785.				
Cockham Wood Fort.	No Guns here at the time of the Survey in the Year 1785.				

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Sheerness Garrison.	42 Pounders	19	—	1	20
	32 Pors	12	2	2	16
	24 Pors	6	—	—	6
	18 Pors	52	—	—	52
	12 Pors	—	—	—	—
	9 Pors	6	6	—	12
	6 Pors	4	—	—	4

12

Surveyed in the Year 1787.

Plymouth Citadel.	32 Pounders of 9½ feet	4	—	25	29
	24 Pors of 9½ feet	15	—	—	15
	18 Pors of 9 feet	15	3	4	22
	9 Pors of 10 & 9 feet	7	1	12	20
	6 Pors of 8½ & 8 feet	2	1	7	10
	4 Pors of 7 feet	—	—	7	7
Mount Wise	32 Pors of 9 ft. 7 incs.	—	—	8	8
Mount Pleasant	18 Pors of 9 feet	11	—	—	11
St. Nicholas Island	32 Pors of 10-9½ & 9 feet	4	—	19	23
	18 Pors of 9 feet	6	—	—	6
	13 Inch Brass Mortars	2	—	—	2
On Plymouth Gun Wharf	From Land Service: 32 Pors of 9½ feet	3	—	—	3
	From Land Service: 24 Pors of 9½ feet	11	—	—	11
	From Torbay: 20 Pors of 9 ft. 2 in.	24	—	1	25
On Plymouth Gun Wharf	From Tenby & Helstone: 18 Pors of 8½ feet	4	—	8	12
	From Tenby & Helstone: 9 Pors of 9 feet	10	—	6	16
	From Withey Hedge: 12 Pors of 9 feet	10	—	—	10
Pendennis Castle	24 Pors of 9½ feet	9	—	—	9
	18 Pors of 9 feet	12	1	1	14
	9 Pors of 8½ feet	8	11	4	23
	6 Pors of 8½ feet	1	3	5	9
St. Maws Castle	21 Pors of 9½ feet	1	—	—	1
	21 Pors of 9 feet	—	—	5	5
	6 Pors of 8 ft. 10 in.	—	—	3	3
	6 Pors of 8 feet	1	2	—	3
Dartmouth Castle	18 Pounders	8	2	—	10
	3 Pounders	—	—	2	2

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13

Surveyed in the Year 1788.

At Gravesend	42 Pounders	—	—	10	10
	32 Pors	11	—	—	11
	24 Pors	4	—	1	5
	9 Pors	1	—	—	1
At Tilbury Fort	42 Pounders	8	—	19	27
	32 Pors	6	—	—	6
	9 Pors	33	—	—	33

14

Surveyed in the Year 1793.

Dover:—					
Archcliff Fort	Iron: 32 Pors of 9½ feet	6	—	—	6
	Iron: 18 Pors of 9½ & 9 ft.	3	—	4	7
	Brass: 10 inch Howitzer	1	—	1	2
Moats Bulwark	Iron: 18 Pors of 9½ & 9 ft.	6	—	—	6
	Iron: 32 Pors of 9½ feet	4	—	6	10
	Iron: 6 Pors of 8 feet	1	—	—	1
	Brass: 10 inch Howitzer	1	—	—	1
Norths Battery	Brass: 10 inch Howitzer	1	—	—	1
	Iron: 32 Pors of 9½ feet	6	—	1	7
	Iron: 18 Pors of 9 feet	2	—	4	6
	Iron: 12 Pors of 9½ feet	2	—	4	6
Amhersts Battery	Brass: 10 inch Howitzer	1	—	—	1
	Iron: 32 Pors of 9½ feet	3	—	—	3
	Iron: 18 Pors of 9 feet	4	—	2	6
Townshends Battery	Brass: 10 inch Howitzer	1	—	—	1
	32 Pors of 9½ feet	6	—	—	6
	18 Pors of 9 feet	1	—	2	3
Folkestone	9 Pors of 9 feet - Received 5 - Condemned 1				
Sandgate Castle	18 Pors of 9½ feet - Received— - Condemned 10				
Hythe	18 Pors of 9 feet - Received 6 - Condemned —				
Rye	Brass: 6 Pors of 7 & 8 feet	—	3	3	
	Brass: 3 Pors of 9 feet	—	1	1	
	Brass: 3 Pors of 7½ feet	—	1	1	
	Iron: 24 Pors of 10 feet	2	8	10	
	Iron: 18 Pors of 9 feet	—	2	2	
Hastings	12 Pors of 9 feet	11	—	11	

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Seaford	12 Pors of 9 feet	3	2	5
Blackington	24 Pors of 10 feet	5	—	5
Newhaven	18 Pors of 9 feet	3	2	5
Brighthelmstone	24 Pors of 10 feet	11	1	12
Arundel Castle	18 Pors of 9 feet	6	1	7
Calshot Castle	18 Pors - No. 9 6 Pors - No. 4	These Guns were not tried by the Instrument on the Survey in 1797 as they appeared old and worn out.		
Hurst Castle	18 Pors - No. 14 6 Pors - No. 8	On the Survey in the Year 1787 these Guns were considered as old and worn out.		
Cowes Castle	9 Pors - No. 10	On the Survey in the Year 1787 these Guns were considered as old and worn out.		
Sandown Fort	9 Pors - No. 20	On the Survey in the Year 1787 these Guns were considered as old and worn out.		
Yarmouth	9 Pors - No. 4 6 Pors - No. 8	On the Survey in the Year 1787 these Guns were considered as old and worn out.		
At Margate	24 Pors of 9½ feet 18 Pors of 9 feet	4 3	— 3	4 6

N.B. Two light 6 Pounders of 4½ feet belonging to the Town are Mounted at the Pier: They were cast by Messrs. Wright & Pricket in 1779.

Broadstairs	12 Pors of 9 feet	4	—	4
Ramsgate	12 Pors of 8½ feet 9 Pors of 9 feet	— 3	4 1	4 4
Sandown Castle	9 Pors of 9½ feet	4	5	9
Deal Castle	9 Pors of 9½ feet	9	2	11
Walmer Castle	9 Pors {9½ feet {9 feet	7 6	2 3	9 9

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CALCULATIONS NECESSARY FOR THE CONSTRUCTION OF DUG-OUTS AND GUN PITS.

By Temp. Major F. M. G. DuPlat-Taylor, R.G.A.

IN the construction of gun emplacements, fire trenches and dug-outs, shell and cartridge pits etc. all sorts of material has to be used, not only timber etc. supplied by the R.E. but material arising from the demolition of old buildings etc.; and a knowledge of the loads likely to be imposed upon such structures, and of the capabilities of the materials to bear the loads, is of considerable use to an Artillery officer.

Judging the size of timber to be used by eye is a dangerous proceeding and may result either in a collapse of the structure or in the wasteful use of heavier timbers than are necessary; timber, steel joists and similar material being extremely scarce and valuable at the present time.

Strength of Timber:—

Several formulæ are available in Military Handbooks, but those usually accessible to an officer in the field are those contained in G.A.T. Vol. 3. and in the Manual of Field Engineering. The former are only intended for service stores, or selected material, though values are given for unselected timber as well; those in the latter volume are intended for unselected timbers used for bridging purposes

Neither of these quite meet the case of semi-permanent structures such as dug-outs, where the beams are often with built-in supports, and the loads to be carried are not only the dead loads of superincumbent material, but the blows due to shell bursting in or near the overhead cover.

Timber Beams:—

Timber beams are always of rectangular form, round spars being unsuitable for the purpose. Beams may be either merely supported at the ends, or built in at the ends, i.e. embedded in the structure; and they may carry either a single load or a continuous load, (for the purposes of calculation two or more loads may be considered as a continuous load). Cantilever beams are always built in, and they may likewise carry a single or distributed load.

Beams supported at both ends and loaded at the centre:—

Formula in G.A.T. Vol. 3.

(1) $$W = \frac{bd^2}{l}$$

Where b = breadth in inches
d = depth in inches
l = length between supports in inches.
W = *safe* load in *tons*

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The above is for selected timber of baltic fir. If for oak, multiply the result by 2, for pitch pine by 1·5, or elm 0·6.

Formula in M. Field Engineering.

$$(2) \qquad W = \frac{bd^2}{2L} \times K$$

Where b & d are in inches
L is in feet
W is *safe* load in *cwt.*
K is a constant:—

for larch or cedar	1.
for baltic fir	5/4
for yellow pine	6/4
for beech and oak	7/4

The above is for unselected timber in each case.

Take a beam 10 feet long between supports, of baltic fir 10 inches square: By formula (1) it will carry 8·3 tons; and by formula (2), 3·12 tons. An oak beam of similar dimensions will carry 16·6 tons and 4·375 tons respectively.

It will be seen that there is a considerable difference in the results, which is liable to be misleading. This is due to the fact that the safe loads are arrived at by allowing wide variation for selected and unselected wood, and the factors of safety are in one case 2 and in the other 4·5.

As the timber used in the structures we are considering may be of very varying quality and strength, it will be better to use a formula giving the ultimate or *breaking* strength, and then to make any necessary allowances according to circumstances. Without therefore examining any of the remaining formulæ in G.A.T. or the Field Engineering Manual, I propose to give the formulæ for calculating the breaking weight in each class of beam:—

These formulæ require the use of a constant K, which has the following values:

Beech	13
Fir	12
Deal	14
Oak	17
Red pine	13
Pitch pine	15
Yellow pine	10
Memel	12

In each formula b is the breadth of beam in inches, d its depth in inches and L its length in inches, W being the breaking weight in *cwt.*

For beams loaded in the centre and supported at each end:—

$$(3) \qquad W = \frac{4 K b d^2}{L.}$$

Taking our fir beam 10 ft. by 10 inches square, we have a breaking weight of 20 tons, and for an oak beam a breaking weight of 28·3 tons. Allowing a normal factor of safety of 4, we get a working

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load of 5 tons and 7·07 tons respectively, which may be compared with the results previously obtained from formulæ (1) & (2).

Beams supported at both ends, with equally distributed loads :—

$$(4) \qquad W = \frac{8\,k\,b\,d^2}{L}$$

The 10 foot fir beam will here support 40 tons, or double what it will carry as a single load, before breaking ; and the oak beam will similarly require a distributed load of 56·6 tons to break it. Allowing the factor of safety of 4, they will safely carry 10 tons and 14·15 tons respectively.

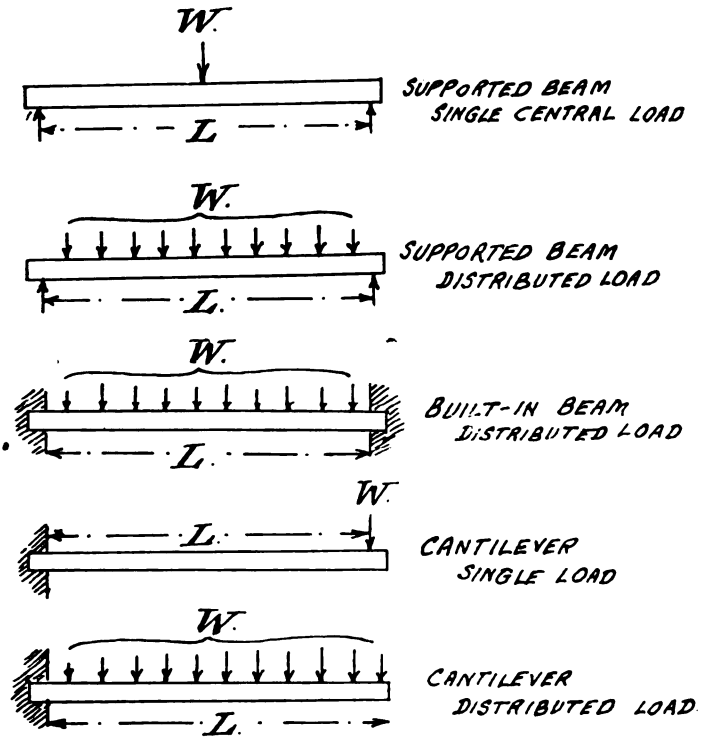

FIG. 1. Beams.

Calculating the same beams with the formulæ in G.A.T. and Field Engineering we get :—

	Safe distributed loads.	
	Fir beam.	Oak beam.
G.A.T. Vol. 3	16·6 tons.	33·3 tons.
Manual Field Engineering ...	6·25 tons.	8·75 tons.

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Beams with both ends built in, and carrying distributed loads:—

$$(5) \qquad W = \frac{12\ K\ b\ d^2}{L.}$$

The 10 foot fir beam will now require 60 tons, and the oak beam 84·9 tons to break them, and the safe loads will be 15 tons and 21·23 tons respectively. No corresponding formulæ are given in G.A.T. or Field Engineering.

Cantilever beams:—

With single load:—

$$(6) \qquad W = \frac{K\ b\ d^2}{L.}$$

A fir cantilever 10 feet long, 10 inches by 10 inches, will be found to have a breaking load of 5 tons, and a safe load of 1·25 tons. An oak cantilever gives a breaking weight of 7·08 tons, and therefore has a safe strength of 1·77 tons.

No corresponding formula is given in Field Engineering, but in G.A.T. Vol. 3 a formula is given from which the safe working load of the fir cantilever would be 2·09 tons, and that of the oak cantilever 4·19 tons, for selected timber in each case.

Cantilever with distributed load:—

$$(7) \qquad W = \frac{2\ K\ b\ d^2}{L.}$$

Or, as in the case of the beam, the cantilever will carry double the load distributed that it will in a single load.

Applying this formula to the ten foot cantilever, we get for fir 2·5 tons, and for oak 3·54 tons safe loads.

For comparison, the formula given in Field Engineering, gives safe loads of 1·56 tons for fir and 2·18 tons for oak on a cantilever of the above dimensions. G.A.T. gives no formula for distributed loads on cantilevers.

The above formulæ (3), (4), (5), (6) and (7), cover all cases which will be required for structures in the field. The factor of safety of 4 is recommended for all ordinary cases. Where, however, very old and dry wood is used, such as old floor joists or beams from buildings, which are liable to be rotten at heart, a factor of safety of 10 might be employed. When a timber is "shaky" or cracked, the defective side should be put on the compression side, or uppermost. When two or more timbers are required to obtain the necessary strength, they must be separately calculated, and not as one beam of the depth of the sum of pieces used. Attention must be paid to getting a bearing, both for abutments and loads, so that the whole width of the beam carries the weight, otherwise the outer fibres may be stressed to breaking point and the beam split vertically before the whole of the timber has received the weight.

With this object, if the beam is not true, flat places should be adzed upon it for the bearings.

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Rolled steel joists:—

These are frequently used, when available.

Depth inches.	Width inches.	Weight in pounds per foot run.	Total distributed load which can be safely carried by spans of:—					
			5 ft.	10 ft.	15 ft.	20 ft.	25 ft.	30 ft.
			Hundredweights.					
3	1½	4	19	9	6	5	—	—
5	3	15	117	58	38	29	23	20
7	3½	20	218	109	73	54	44	36
8	4	25	316	158	105	79	63	52
10	5	29	501	252	168	126	101	84
12	5	32	653	326	217	163	130	108
13	5	40	800	400	266	200	160	133

The strength of intermediate sizes can be estimated by comparison with these figures. There is not the same risk of a sudden collapse with steel joists, as they buckle gradually when too heavy a load is imposed, whereas a timber beam will break.

Struts and uprights:—

The uprights in a dug-out or similar structure are nearly always round or square pit props. It is of the utmost importance that these should have a true flat bearing at top and bottom, as a column with rounded ends has a very much lower value, and struts resting on one edge will probably fail.

Formulæ will be found in G.A.T. Vol. 3 for the safe thrust on spars for repository work, and in the Manual of Field Engineering a series of "graphs" are shown giving the safe load on spars used for trestle legs etc., and also square baulks.

These differ widely, for by the formula in G.A.T. an Oregon spar 50 feet long and 20 inches mean diameter will safely carry 48 tons, whereas according to the graph on Plate 57 in the latter publication it will only carry 8 tons.

Allowing for the fact that the former is intended for service stuff, carefully selected and seasoned, and the latter for forest poles, the discrepancy is still very great; but for our present purpose both should be neglected, and the following formula used.

(8) $W = C \times \frac{D^4}{L^2}$ where, W is breaking weight in tons.
D is diameter of column, or width of least side, in inches.
L is length of column in feet.
C is a constant:—

Oak, round	11
Oak, square	10
Baltic fir, same as for oak.	
Deal, round	7·5
Deal, square	7
Larch, round	5
Larch, square	4·5

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This formula is really correct for struts in which the length is greater than 30 times diameter, but to avoid multiplication of formulæ, it may be taken as correct for all cases, and a greater factor of safety will thus be allowed for shorter struts.

As an example we will take a strut of baltic fir, 15 feet long by 6 ins. by 6 ins., such as would be used in supporting the roof of a gun emplacement.

Then breaking stress would be :—

$$W = \frac{1296 \times 10}{225} = 57{\cdot}6 \text{ tons.}$$

A factor of safety of 6 should be allowed where the ends have been carefully squared and fitted, and 10 for rough work.

The working strength in the first case would be 9·6 tons and in the second case 5·76 tons. The reason of assuming such high factors of safety is that it is much more difficult to accurately fit a strut than a beam, and if not accurately fitted, the weight may be carried on one edge of the strut only and the strength consequently reduced to a quarter of the calculated strength or less. Further, where struts are carried on independent sole plates, instead of a long sill, slight movements in the ground may result in one strut being entirely relieved of its load, and the adjoining struts carrying 50 per cent excess load.

In framing structures, the span of beams may be reduced by means of corner braces, as shown in Fig. 2, but these must be carefully fitted. The strength of the beam may then be calculated as having a span from brace to brace.

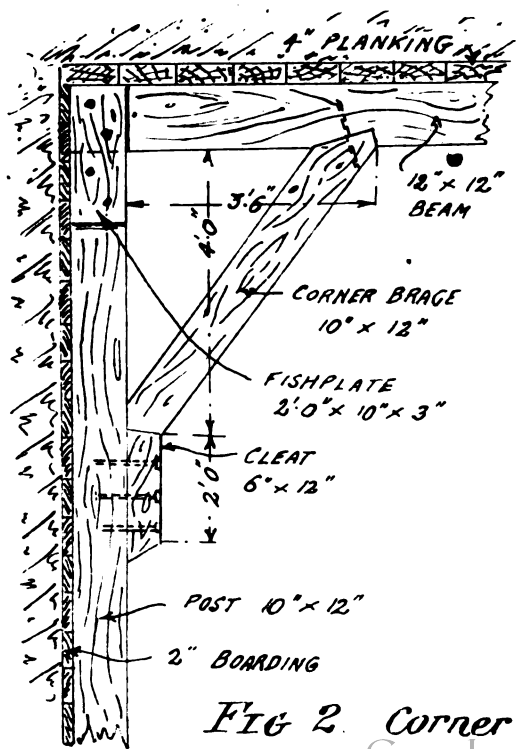

FIG 2. Corner brace.

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***Concrete*:—**

The strength of concrete in beams is very uncertain, when it is mixed and laid by unskilled labour, but formulæ (3) to (7) may be used with a constant 0·3, if the mixture is not weaker than 6 parts by bulk of gravel and sand to 1 of cenment.

The strength of reinforced concrete involves elaborate calculations and neither the calculation nor execution of the work should be attempted; this being entirely done by the R.E.

***Loads imposed upon structures*:—**

To enable the timbering etc. of dug-outs to be correctly designed it is necessary to know something of the earth pressure which will be imposed upon them.

The weight per cubic foot of various soils is as follows:—

Chalk	145 lbs.
Sandstone	133 lbs.
Sand, loose	118 lbs.
Brick, solid	115 lbs.
Brick, broken	95 lbs.
Concrete	125 lbs.
Clay	120 lbs.
Earth, average ...	90 lbs.

Other materials:—

Water	62 lbs.	(fresh).
Timber, pine	36 lbs.	
do. , oak	62 lbs.	
do. , elm	34 lbs.	

In calculating the load imposed by superincumbent earth etc., a distinction must be made between material *refilled* on top of a structure, and earth *in its natural state*, undisturbed, under which a dug-out has been constructed by tunnelling.

In a case where an excavation has been made down from the surface, and a frame structure built, upon which the earth etc. has been refilled, the weight upon the structure will, for all practical purposes, be the net weight of the superincumbent material included in the rectangle A.B.C.D. (Fig. 3).

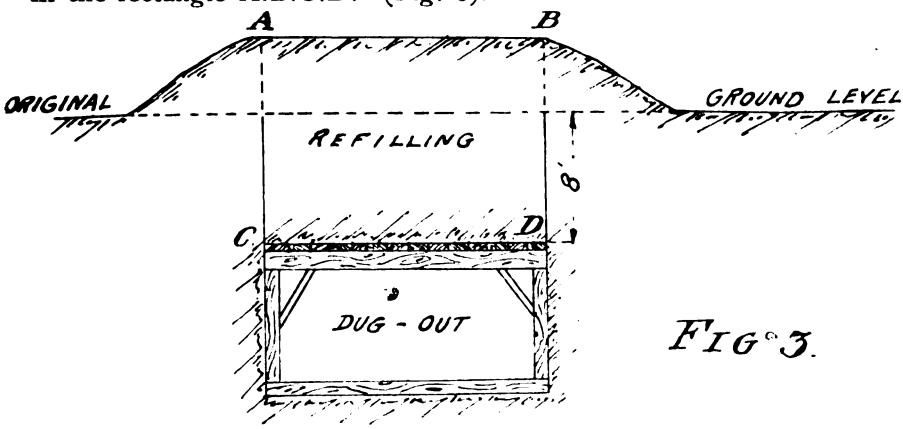

FIG. 3.

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E.G. If the height A.C. is ten feet and the material is light loam weighing 80 pounds per cub. foot, then the weight per square foot of the dug-out roof will be 10 × 80 = 800 lb., and if the dug-out were 10 feet long by 7 feet wide, the total weight upon its roof would be 800 × 70 = 56,000 lbs. = 25 tons.

Actually the weight is less, as friction between the earth surfaces, and also "arching effect" reduces it; but for our purposes it will be best to assume that the full weight is imposed. Where earth etc. is piled upon structures above ground level, this will be strictly correct. Where the dug-out is excavated in the solid, without the removal and refilling of the soil above, a much less pressure is exerted. This is due to the "arching effect", the fact that the particles of soil form a self-supporting arch over the cavity varying in height with the nature of the soil; and, if the supporting roof of the dug-out were to be suddenly removed, only the earth within this arch would in the first instant of time fall. It is therefore only this material, beneath the arch, which imposes its weight upon the roof of the structure.

It is true that the remainder of the ground would probably cave in, but this would be a more or less gradual process.

The tendency to "arch" depends upon the same characteristics of the various materials as determine their "angles of repose".

The angle of repose is the natural slope at which any material will stand when heaped up and exposed to the weather.

Later, in connection with lateral pressures, we shall require to know the "angle of rupture" of various materials, which bears a definite relation to the angle of repose, being the angle of repose plus half the difference between that angle and 90°.

Angles of rupture and repose of soils:—

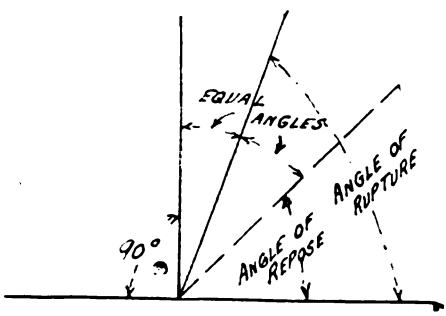

FIG. 5.

Nature.	Angle of rupture.	Angle of repose.
Gravel	... 65	40
Dry sand ...	... 59	38
Sand	... 56	22
Vegetable earth	... 59	28
Compact earth	... 70	50
Shingle ...	... 64	39
Rubble ...	... 67	45
Clay, dry ...	... 67	45
Clay, wet ...	... 53	16

All with the horizontal. (See Fig. 5).

Although the "arching effect" would actually give a curved line of cleavage, and its extent will vary considerable according to whether the ground is dry or saturated, it will be sufficiently near for our purposes in estimating the weight on a tunnelled dug-out to assume that the material, which will fall, is included in a pyramid the sides of which have an inclination to the vertical the same as the natural slope has with the horizontal.

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Consider a dug-out (Fig. 4) 20 feet deep.

The weight upon it will, according to the above assumption be that of the ground included in the pyramid B *a'* D, where the angle *a'* DC (or *a'* BA) is the same as the angle of repose of the material. state, the conditions approximate more to those of fluid pressure, and it would be safest to take the weight of the whole rectangle ABCD (Fig. 4).

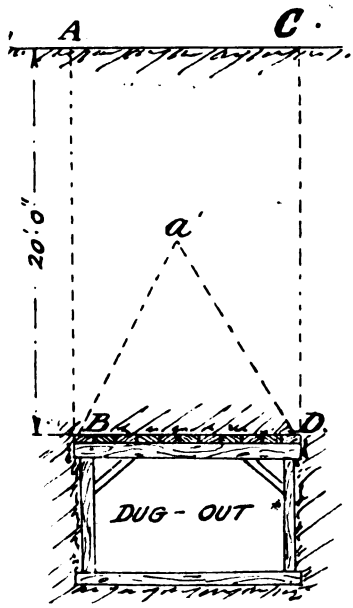

FIG. 4.

The contents of a pyramid are obtained by multiplying the area of the base by ⅓rd. the vertical height.

Lateral pressure :—

If timber is used in any structure it must be strongly framed and braced together, so as to form a complete substantial structure. Frames without bracing or stiffening between them may be pushed bodily inwards.

The lateral pressure on any vertical surface AB (Fig. 6) may be obtained as follows :—

Set off BB', making angle *x* equal to the angle of rupture of the material.

Bisect AB' in C.

Join BC.

Set off on BC, from C, a distance CD equal to one third of BC.

Then the point D is the centre of gravity of triangle ABB'. Drop a perpendicular from D to cut BB' in E.

Draw a horizontal EH, through E. This will be the centre of pressure, or mean line of pressure against the vertical surface AB.

Take the area of triangle ABB' in square feet (½ base multiplied by perpendicular) and multiply this by the weight of the material per cubic foot.

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Set off EG equal to this weight to any scale (say 1 inch equals 1 cwt.).

Through G draw GH parallel to BB'.

EH will give the total pressure, per foot run, on the vertical surface AB, to the same scale.

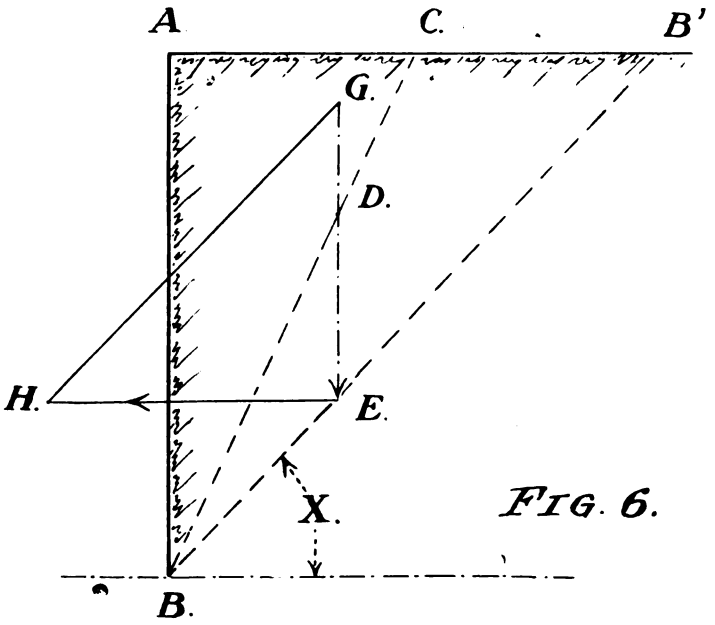

FIG. 6.

E.G. If the total pressure against each foot run of a dug-out wall AB, ten feet high, is found to be 4 tons; and the dug-out is 20 feet long, then the total pressure against that wall will be $4 \times 20 = 80$ tons, and if the vertical posts supporting the revetment are spaced 5 feet apart, the three middle posts will each have to resist a lateral thrust of 20 tons, and the two end posts 10 tons each (in this direction, though they will also carry an end thrust from the material behind the end walls).

To resist the lateral thrust the posts must be considered as upright beams, and must be well morticed or braced to the top and bottom sills or timbers.

The above, again, is only an approximation, as friction has been neglected, and this tends to make the conditions better.

Again a considerable factor of safety should be allowed, to cover additional lateral thrust due to shell bursting in the earth outside the framing, and in a lesser degree to alteration of the angle of rupture due to very wet weather saturating the soil.

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NOTES ON THE IDENTIFICATION OF POINTS.

By Capt. K. F. W. Dunn, R.F.A.

PROFICIENCY in Map Reading is a result of practice which helps also to cultivate "an eye for country," a most invaluable asset to any one who has to work quickly with a map.

But without being anywhere near proficient, or even having "an eye for country" to any marked degree, it is not a very difficult matter to recognise the various features in a landscape provided we set about it on sound lines and do not forget to use common sense.

Before going out to the particular spot or area where our O.P. is to be situated, a careful study of the Map will, as usual, repay us amply. If we have time this preliminary study can be made vastly more useful by the following additions to the Map:—

(a) Layering it.

(b) Marking ground which must be invisible—remembering that trees, etc., will further restrict our view, and that this will be the maximum we can expect to see.

(c) Marking the skyline and the crests of any other hills.

(d) If time is short it is better than nothing to mark streams in blue and the various crests with a pencil line.

A beginner should remember that the things which strike him most on looking at an ordinary Map will not necessarily be those which catch the eye on the ground. For instance, on looking at a Map, a large town, a Canal, a Railway, or a Road may stand out prominently; but on the ground the town may be hidden by a hill or by trees, a Canal will probably not be seen at all, while occasional telegraph poles showing between trees may be the only indication of a Railway, and an odd sign-post all there is to betray the existence of a Road. In practice it will be found that it is the hills which form the main features, and buildings and other objects which are thrown into prominence by them.

It is, therefore, all-important to get the hills, as they will appear, fixed in one's mind before looking at the country, as they are almost invariably the key to all successful reading of the Map. For this purpose a layered map is invaluable.

On reaching the ground the first thing to do is to fix our position. On the way out the route should be followed carefully by the local detail so that at any moment we have a very fair idea of where we

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are. Knowing roughly our position we can "set" the map by the most suitable means—Compass, Sun, prominent objects, etc.—and choose points from which to resect. If using compass and two points the latter must be sufficiently wide apart to give a good intersection. The greatest care must be exercised when using a compass to see that it is not affected by any iron; this is particularly necessary in Trench work, and for this reason a sextant will frequently be used in its place. The error of the compass used should always be known.

If our position, found by resection, does not come where we expected, it is not right to assume straight away that the local detail is wrong. All angles and plotting should be checked over again; if the position still comes in the same place there are three possibilities:

(1) Inaccurate working.

(2) The points used for resection have been wrongly located. (This is the usual cause when position is far out).

(3) Local detail inaccurately marked or map stretched.

Having finally fixed our position to our satisfaction we now proceed to locate other points in our landscape. In this work there are three main conditions to be satisfied:—

(1) The Bearing or Direction of an object;

(2) The Shape of the Ground; and

(3) The Range.

Further information may often be obtained from the local detail immediately surrounding the point; also its position can sometimes be seen to be definitely beyond some road, railway, trench, etc., already located.

Considering each in detail:

(1) The Bearing or Direction of an Object.

The bearing may be taken with an ordinary prismatic compass, the usual precautions being taken as to iron, etc. If two O.P's can both see the same object cross bearings can be taken which should fix its position straight away. Probably the most convenient method, when several points have to be recognised in a zone, is to identify some prominent object to be used as a reference point and to measure the direction of other objects as so many degrees right or left of this point. These angles are measured with graticuled glasses, a sextant, or protractor and gut. To simplify the plotting of results it is convenient to rule degrees right and left of the Reference Point on the map; the True or grid bearing being written along the line to the Reference Point to facilitate the sending of reports where the bearing is needed.

(2) The Shape of the Ground.

Having established the direction of an object the next thing to do is to examine the shape of the ground round it. Is it on a ridge or in a valley? Is it on a forward slope or a reverse slope? Is it on the first ridge or the second, or is it on our skyline? If it becomes difficult

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to see much of the surrounding country it may *generally* be assumed to be on rising ground; otherwise, it would not be so likely to appear prominent.

Here comes the advantage of our layered map with crests and skyline marked. A Farm on a bearing of 60 degrees on the skyline should not present many further difficulties, nor should a Church spire on a given bearing just showing over the first crest but unmistakably between us and the second.

This, together with the bearing, is probably our best guide in fixing the position of objects. There is, however, one warning necessary; estimation of the angle of sight is dangerous. It is not even wise to say that such and such a point appears higher than we are; it is so deceptive that judging by shape alone is soundest. On the other hand, if the angle of sight can be *measured* (with graticuled glasses or otherwise) as so many minutes greater or less than that to a previously located point or crest, the angle of sight to which can be calculated from the map, it will be found a useful check on occasions.

(3) The Range.

As it is not practicable to have a range-taker always available the range will have to be estimated. Estimating a few hundred yards is one thing, but estimating ranges running into thousands is quite another, the ruling factor in this case being the visibility of the atmosphere. It is well to remember that on a typical winter morning in North-West Europe two or three miles or less is frequently the limit of visibility, while on a clear summer evening ten times these distances is nearer the mark. The tendency of the beginner is to place far too much reliance on his estimation of ranges, but range should be the last of the three conditions to be satisfied. It is sometimes of assistance in estimating a range to compare it with the range to a known point. Too accurate estimation should not be attempted; it is best, when dealing with long ranges to judge to the nearest mile or thousand yards, and then to look on the map at about that distance for country whose shape satisfies the other conditions.

A few other points are sometimes of assistance, though they are not hard and fast rules, and there are many exceptions—

Buildings.

are usually fairly near metalled roads; Villas and Cottages, particularly rows of Cottages are generally right on a road; Farms are a little farther off the roads, and some of them, and also large country houses, may be right out in the middle of fields.

Trees.

A thick screen of trees (e.g., the trees round a Belgian Farm) may easily be mistaken in summer for a wood. A line of trees may be fixed by means of an Aeroplane photograph and may form a useful datum point, or may mark a road otherwise invisible.

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Roads.

Main roads are usually marked by a line of Telegraph Poles, a double hedge in England, or a line of trees at equal intervals in France, and occasional houses and cottages. Traffic and movement, dust, etc., may also help to show their course.

Cross Roads

may be spotted by means of a sign-post and often by an Inn.

Railways

generally present a long straight, level line to the eye. They invariably have telegraph posts along them, and occasional signal posts, cabins, etc. Bridges and Embankments may also be seen. If a railway is not near the front line and is in use by day, the smoke of trains can be seen for miles. By this means it is possible to locate stations and sidings where trains stop or can be seen shunting.

Both roads and railways can give definite information as to the position of other points, e.g., whether the points in question are beyond or nearer than a railway which has already been fixed.

Panoramas.

A panoramic photograph, or failing this a panoramic sketch showing the Reference Point and main features, is of assistance to anybody studying a piece of ground for the first time.

FLYING.

It is notified for general information that the lecture delivered at the R.A. Institution on the 17th January, 1918, by Colonel A. C. H. MacLean, Royal Scots, on the above subject, and printed on pp. 385 to 393 "R.A. Journal", Vol. XLIV of February 1918, was founded upon data gathered from his own experience in the Royal Flying Corps both before and during the present war. The opinions expressed therein must not, therefore, be taken as representing the official views of the Air Council.

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Contents of R.A. Journal, July, 1918.

The Modern Attack on an Entrenched Position. By Colonel H. A. Bethell, C.M.G., R.F.A. 121

Comparative Calibration in the Field. By Major C. Q. L. Penrose, M.C., R.G.A. 130

Drift with the 15" Howitzer. By Major L. E. Booth, M.C., R.F.A. 134

Ranging on the Line of Observation without the use of Factors. By Bt. Col. A. ff. Powell, D.S.O., R.A. 136

The Long Range Gun. A Lecture delivered at the Royal Artillery Institution, Monday, 13th May, 1918. By Major J. Maitland-Addison, R.A. Brig.-Genl. A. Stokes, C.B., C.M.G., D.S.O., R.A. in the Chair. 137

Notes on the Errors of Vertical Base Range-Finders. By Lieut. A. Hutchison, Clyde R.G.A. (T.) 151

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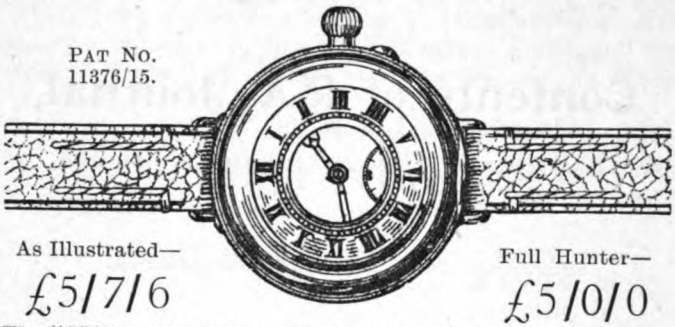

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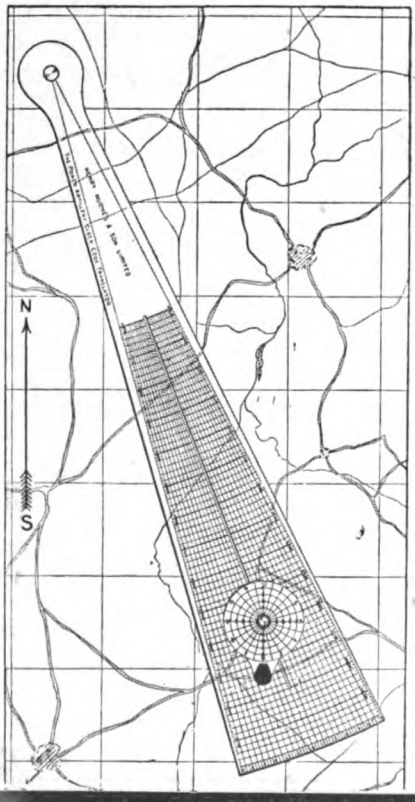

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THE MODERN ATTACK ON AN ENTRENCHED POSITION.

By Colonel H. A. Bethell, C.M.G., R.F.A.

(This article is based on the published accounts of the German offensive of March 21-30, 1918. It is intended as a summary, in convenient form, of the latest German methods, especially with regard to the employment of Artillery. The information is taken from Sir Douglas Haig's despatches, and some of the details are from Mr. Hamilton Fyfe's correspondence).

THE normal fighting strength of a German division is 12,000 rifles, 54 field guns, and 18 4·2″ light field howitzers. It has been stated in the Press that the infantry of a German division has recently been reduced from 12 to 9 battalions, or 9,000 rifles at full strength. However it seems probable that the effective strength on 21st March did not exceed 7,200 rifles per division. This agrees with Sir D. Haig's estimate of 15,000 of all arms to a division.

The Artillery is supposed to have been up to strength in guns, and in some cases to have been reinforced by Austrian batteries. (Sir D. Haig, 22/3/18). Counting a proportionate share of the Corps and Army Artillery, but not the Austrian batteries, the strength per German division on 21/3/18 may be taken at:—

7,200 rifles, 54 field guns, 18 light field howitzers, 8 heavy (5·9″) field howitzers, 8 6″ guns, 4 medium siege howitzers, 2 heavy (12″) siege howitzers.

I think this estimate errs rather on the side of moderation.

The German strength on the Western front is officially estimated at 200 divisions, of which 85 were in reserve. The attack on 21st March was delivered by 40 divisions (Sir D. Haig) reinforced on 22nd by 33 divisions from reserve and on 23rd by 21 divisions from reserve, total 94 divisions. This left 31 divisions still in reserve.

The original attack was on a 60 mile front (Vimy to La Ferè) but after the failure of the attack on Vimy and Arras it was continued on a 50 mile front, from Monchy to La Ferè. Deducting say 8 divisions still left in the Vimy—Arras sector, we get a total of 86 divisions used on a 50 mile front in 10 day's fighting, with a general

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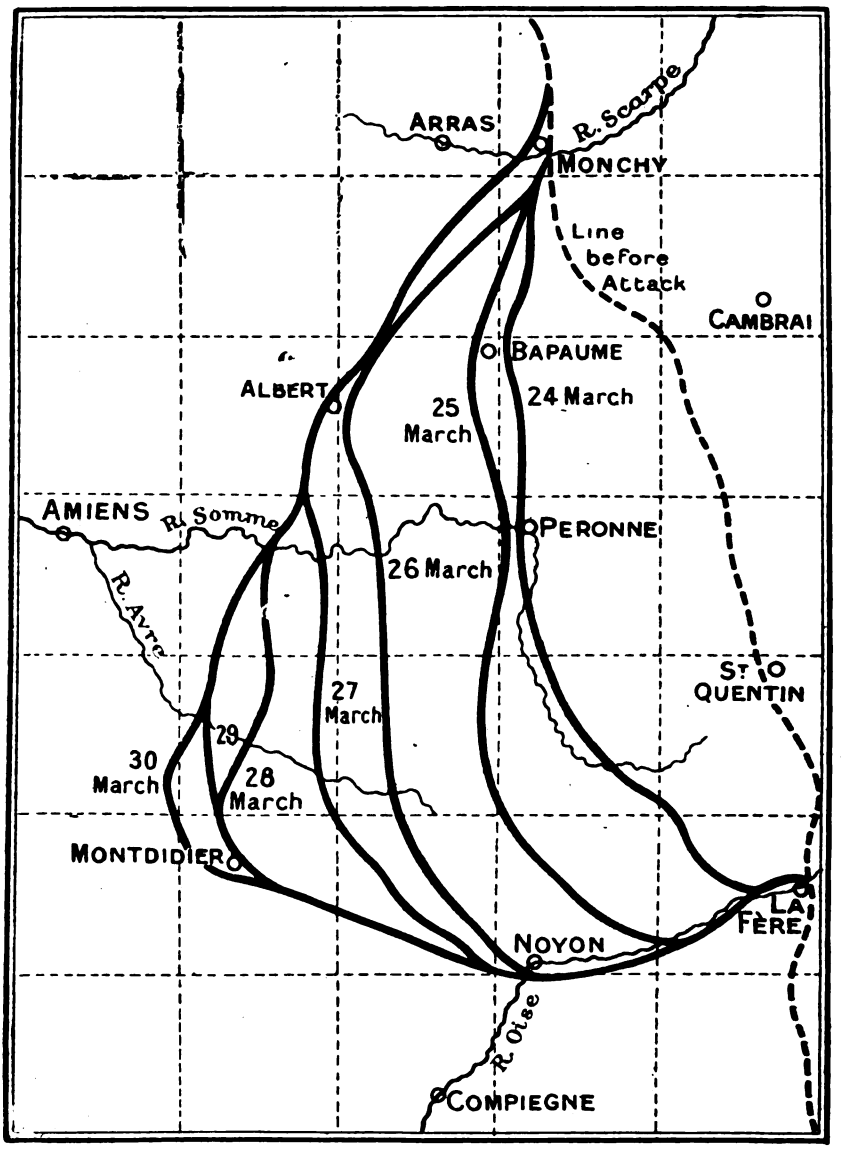
GERMAN OFFENSIVE ON THE SOMME

March 21 to March 30, 1918.

Ten-mile squares.



reserve of 31 divisions intact somewhere behind them, for use in case the attack succeeded in finally breaking through the Allied line. Some of these divisions were used 3 and 4 times. Dividing 86 by 50, we get an average of nearly 1¾ divisions per mile of front.

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This gives the following average distribution:

Infantry:

6·6 rifles per yard of front.

Artillery:

1 field gun	per	19	yards	of front.
1 light field howitzer	„	57	„	„
1 heavy field howitzer	„	128	„	„
1 6″ gun	„	128	„	„
1 medium siege howitzer	„	256	„	„
1 heavy siege howitzer	„	512	„	„

Since 33 + 21 divisions were put in as re-inforcements, it is probable that their field guns and light field howitzers were not all in position for the week's bombardment which preceded the attack. But we may safely say that the whole of the heavy calibres took part in this bombardment. The difficulty in finding enough positions for them may be gathered from the figures given above.

In the accounts given by war correspondents we read that:

"On the front of one Corps there was a gun to every 15 yards". (Hamilton Fyfe, 22nd March).

"On one Corps front of 2 divisions, the enemy used some 700 guns on the first day". (H.F., 23rd March).

"Between Cambrai and Bullecourt the Germans had 8 divisions on a front of 10,000 yards", or 5·76 rifles per yard. (H.F., 23rd March).

"The Germans had 14 divisions on the front between the Somme and Montdidier, on a front of 20 miles", or 3 rifles per yard. (H.F. 4th April).

These quotations do not include divisions brought up on the following days as re-inforcements.

It is presumed that, in accordance with modern practice, the guns were considered as belonging to the ground, not to the formations, and that they supported the attack of successive divisions advancing on the same front.

General Principles of the Attack.

The attacking commander expects, or at least hopes, that the defender will keep his front trench, and his support trench ½ mile in rear, fully manned, as he does not know when the attack will be launched. The men in these trenches will suffer heavily, as both trenches will be practically obliterated by the bombardment. Therefore the resistance experienced here should be slight.

Wherever the defender gives way, the attacking troops must follow him closely, in order to outflank and cut off the portions of the line which have not given way. The principle of limiting the depth of the objective does not apply to an attack in mass with large reserves behind it; on the contrary, it is desirable to push forward as far as possible wherever the defending line gives way, and to take the risk of the salients thus formed being cut off.

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The attack must be pushed without intermission. The great force employed, probably at least 10 rifles per yard on the sector attacked (see below) admits of many successive waves being launched within one day. As each of the 3 divisions used on the same front secures its objective, the division in rear passes through it and captures the next line of trenches, and so on. The limit is the rate at which the guns, especially the heavies, can be pushed forward.

Thus the German official report of 24th March says:

"Light, heavy and the heaviest artillery and mine-throwers, unceasingly pushing onward over the crater-field, essentially contributed to the support of the infantry attack, which was continuously pressed forward".

This concurs with our own report:

"Another cause of their rapid progress is the rapidity with which they brought up their field guns". (H.F., 26th March).

A captured German order directs that, in order to follow up the enemy closely, not only battalion and regimental commanders, but also generals commanding divisions, are to keep well forward.

Preparations for the Attack.

These involve a great deal of labour, mostly found by the divisions in reserve. The whole of the attacking force cannot be quartered immediately in rear of the fighting line; therefore railways must be made to bring up the infantry quickly. Roads must be made and repaired for the artillery to advance by. Battery positions must be dug and ammunition accumulated on a vast scale. Field hospitals and clearing stations must be prepared, and road metal, rations, and supplies of all kinds collected.

Thus our airmen reported that,

"All the roads were made good for traffic right up to the front, in some cases to the support trench, and flanked by macadam tracks. They were repaired as fast as we filled them with holes".

German prisoners complained that before the battle they had been worked mercilessly at making roads and railways.

Conduct of the Attack.

As we have seen, the troops employed on the 50-mile front averaged 1¾ divisions per mile. But the infantry attack was not pressed on every mile of the front. The German official report of 22nd March says "We stormed the enemy's line in broad sectors." If we assume that the attack was pressed on alternate sectors of the front, leaving a holding attack on the intervening spaces, which seems a reasonable estimate, then we get 3 divisions per mile, or 11·3 rifles per yard, employed during the first 3 day's fighting on the sectors where the real attack was delivered. This would not affect the distribution of the artillery, which would want every yard of front that it could get, and would be equally distributed along the line and its fire concentrated on the real attack sectors.

The scheme then works out on the following lines:

Each division attacks on a front of one mile and penetrates 1

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mile before it stops. It attacks in 3 lines; if each consists of 3 battalions, the front of a battalion is ⅓ mile. Each battalion advances in 2 waves each of 2 companies, together 250 rifles, (see below) thus on a front of ⅓ mile we get 6 successive waves of 250 men.

The 3 divisions are launched at intervals which may vary from one day down to six hours. At the latter rate there may be as many as 18 successive waves advancing on the same front of ⅓ mile within one day.

The whole of this is repeated 3 times, thus gaining a total depth of some 9 miles.

Great use is made of machine guns and trench mortars pushed forward close behind the leading wave. Thus an eye-witness quoted in the Press, (Hamilton Fyfe's report, 23rd March) says:

"The first wave to cross No Man's Land consisted of about 250 men with light machine guns, almost shoulder to shoulder. A hundred yards behind came another line of 250 men, then more machine guns. Next, after an interval of two to three hundred yards, came light trench mortars and the battalion staff. Again a space of two hundred yards, and then, from prepared exits from the trenches, the field artillery drove out into the open in column, forming line of batteries as soon as possible".

Reuter's correspondent with the French G.H.Q., writing on 26th March, says:

"In these attacks the Germans are using a new type of low-built 3-inch field gun, which is as easily moveable as a mountain gun, and which accompanies the infantry in its advance". This may be the Austrian field gun, which is known to be mounted on a special low narrow-gauge carriage for mountain work.

The Artillery Programme.

This is as follows:

1. All the heavy artillery, and the artillery of the divisions first put in, is got into position. If there is room, the artillery of the divisions which are to be put in later is also got into position.

2. A week's general bombardment of the enemy's first, second and third lines: of all gun positions, roads, villages, railway junctions, &c., up to some 10,000 yards in rear of his front line.

3. Six hours' heavy bombardment of 1st, 2nd and 3rd lines and gun positions with H.E., shrapnel, and gas shell: wire-cutting up to a range of 2,700 yards from gun positions.

4. Rolling barrage from field guns, starting when infantry go over the top and preceding them all the way.

5. Bombardment of enemy's front trench, lifted on to his support trench when infantry go over the top. This is repeated as each successive trench is taken.

6. As soon as the front trench is taken, the field guns of one division advance to within wire-cutting distance (if possible within 1,500 yards) of the next trench. This is repeated as each successive trench is taken.

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7. About one-sixth of the field guns are pushed forward to short range to knock out pill-boxes, machine gun nests and the like.

As regards (1) it is uncertain whether the Germans put in the whole of the field artillery of the reserve divisions afterwards used, before the attack. Probably they put in as much of it as they could find room for.

As regards (3) it is recorded that in the later stages of the attack the Germans had to do a great deal of their wire-cutting by hand, covered by their advanced machine guns. It is not stated in any of the reports whether they used trench mortars for cutting wire beyond the original effective wire-cutting range of their field guns.

As regards (4), the rolling barrage preceding the infantry seems to be a regular feature of all attacks now-a-days, except surprise attacks in a mist. The Germans call it the *Feuerwalze,* or "roller of fire."

As regards (7), the reports concur that field guns were regularly pushed forward in close support; this is provided for in the German Artillery Regulations, para: 471. We are not told what proportion were so used; the estimate of one-sixth given above is a mere surmise. Much would depend on the ground. Para: 467 lays down that "Whenever there is a possibility of the situation developing so as to require quickness in opening fire, or rapid changes of target, the semi-covered or the open position must be used. As the infantry attack progresses, cover for the artillery becomes of minor importance." Accordingly we read that: "Between Quéant and Pronville the German guns disdained all cover when the battle began." (H.F., 22nd March).

Expenditure of Artillery Ammunition.

For every mile of the 50-mile front, the expenditure for a week's bombardment followed by a three days' attack may be estimated at:

Class:	Field gun	Light Field howr.	Heavy (5·9") field howr.	6" gun	Medium Siege howr.	Heavy Siege howr.
Number:	95	32	14	14	7	3½
General Bombardment of one week	100,000	10,000	10,000	5,000	2,500	500
Six hours' heavy bombardment ...	33,000	5,000	2,500	1,000	500	100
Rolling barragé	25,000	—	—	—	—	—
Bombardment during attack ...	—	5,000	2,500	1,000	500	100
Wire cutting	18,000	—	—	—	—	—
Close support	2,000	—	—	—	—	—
Total ...	178,000	20,000	15,000	7,000	3,500	700
Total per gun ...	1,873	625	1,071	500	500	200
Maximum rate of fire per hour per gun (during 6 hours' bombardment)	57	26	30	12	12	5

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This estimate may seen high, but we must not be afraid of big figures if we want big results. In this connection a senior Staff Officer at G.H.Q. is reported to have remarked:

"The Boche is thorough. 'How much can we do with?' he asks himself. And when he has worked it out he orders just double the amount to make sure. That is what he did here."

It is assumed in the above table of ammunition that the whole of the field guns and light field howitzers of the 86 divisions were put in for the 6 hours' bombardment, as well as the whole of the Heavies. If we accept the estimate of field gun and light field howitzer ammunition, then it follows that these pieces must have been put in, although 33 of the 86 divisions did not come in till the second day of the battle, and 21 did not come in till the third day. For the rate of fire, 57 rounds per gun per hour for 6 hours, and 26 for the howitzer, is already high, and must have been much higher if only the guns of the original divisions had been used. Perhaps this is the explanation of why the Austrian guns were required to supplement the divisional artillery.

General Principles of the Defence.

The attacker hopes that the defender will keep his front trench, and his support trench ½ mile in rear, fully manned, to hold them against surprise attack in force. If he does so, the troops holding these trenches will suffer so heavily from the bombardment as to reduce their power of resistance to a very low level. Therefore the defender should hold his front trench and his support trench lightly. He must then either reinforce them when the attack starts, an operation which is extremely difficult both to time and to execute; or else he must resign himself to lose these trenches temporarily if they are heavily attacked, and must hope to regain them by a counter-attack delivered under conditions favourable to his own troops. This includes both the general counter-attack, delivered when the attacker's reserves are expended, and daily local counter-attacks.

The object of the defender is to get the enemy out of his (the enemy's) trenches and dug-outs into the open, and then to massacre his successive waves with fire from guns, machine guns, and rifles. Even so the remnant of the attacking force will probably suffice to drive out the weak garrison from the almost obliterated front trench and support trench. These troops must retire, keeping touch with one another; if one battalion retires while the one next to it holds out, the latter will be outflanked and possibly cut off. Keeping up control and communication from front to rear during a retirement is a very severe test of staff work, and keeping up lateral liaison is an equally difficult problem for unit commanders.

It is clear that when the attacker has gained the front trench he can begin again and apply the same procedure to the trenches in rear. But at each advance he must lose a heavy percentage of men, which have to be replaced from reserves, and it is the business of the defender to make this percentage so high as to exhaust the attacker's reserves while his own line, though drawn back, is still unbroken, and his own reserves intact. Then is the time for the defender to assume

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the offensive in his turn. If he has carried out his retirement from successive lines correctly, he will now enjoy a numerical superiority, and will have the advantage of fighting on his own familiar ground.

The above elementary theory of the defence may appear so obvious as to be hardly worth writing down. But it is desirable to state these principles clearly, because they govern the action of the artillery.

In considering this, it must be presumed that at the outset the attacker is in superior force, or at any rate that the defender does not elect to apply a force equal to that of the attack. If the opposing artillery forces were equal, and equally lavishly supplied with ammunition, then the defender would return shot for shot, bombardment for bombardment; the front and support trenches on both sides would be wiped out, and the hostile forces would finally be separated by a two-mile zone of destruction which no troops could cross. It would be a case of the Kilkenny Cats.

We will therefore consider the procedure when the defender elects to retire slowly from successive lines. It is unnecessary to dwell on the preliminary stages, when the artillery does all it can to inflict loss and damage on the enemy during the assembly of his men and guns.

The first thing that happens is the S.O.S. from the front trench when the first wave of the attack goes over the top. In response to this, a heavy barrage is put up over No Man's Land by the field guns detailed for this purpose, while other field guns and field howitzers barrage the enemy's front trench and communication trenches. As the active defence of the front trench is assumed to be weak, the barrage alone will not stop the attack. But it will cause many casualties, which is the main object of the defender.

Simultaneously the whole of the Heavies of the defence open on the attacker's guns, which have just lifted on to the support trench. Observation of fire will be very difficult owing to the smoke of the barrages, even if good O.P's are still available behind the lines, and it will be necessary to trust to previous registration and to the aeroplane photos.

Next follows the stage when the defending troops retire, as per programme, from the front trench. They are screened while retiring by a counter-barrage; that is to say, the defender's barrage is rolled back from No Man's Land, and is kept in front of the first wave of the attack and behind the last of the retiring defenders. (This is easier said than done, but this is the ideal to strive for.) The light field howitzers of the defence now turn on to the evacuated front trench; the Heavies continue to fire on the attacker's guns.

The same precedure is repeated in the defence of the support trench, ½ mile behind the front trench.

When the defenders retire from the support trench, the first wave of the attack will be getting within effective rifle range of the defender's field guns and light field howitzers. Now, the defender does not wish to sacrifice the whole of his field guns, but it is most desirable that some at least of these should remain in action till the attack is within 500 yards or less, even if they have at last to be

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abandoned. They will have a chance of putting in gun fire point-blank at the enemy's masses, and will do more execution in a few minutes than in months of ordinary trench warfare. Moreover if the attacker brings up light guns and tanks it will be absolutely necessary to have guns on the spot (not 2,000 yards distant) to knock them out.

All the accounts from the front show that this is what we did during the recent German attack.

"The enemy's formations were split and rent again and again by two batteries of our field guns firing point-blank into the brown. Two of the guns were knocked out by direct hits, two had all their horses killed, and were blown up. The rest got off." (Hamilton Fyfe, March 23rd).

"When you have a field battery firing for seven hours with open sights at large bodies of the enemy coming on steadily not more than 1,200 and sometimes only 600 yards away, the numbers killed must be appalling." (H.F., April 4th).

The best account which has been published of the handling of our guns during the retirement is in the April "Journal", and describes the action of four batteries of "An Old Regular Brigade", which all fought at short range in the open. Nearly every gun, except those smashed, got away safely. This was principally due to the effectiveness of their own fire.

Other accounts speak of guns which remained in action long after their infantry had retired past them. Even the Heavies enjoyed the novel experience of a scrap in the open. Thus a German newspaper, the Kiel Neueste Nachrichten, says on 29th March:

"A heavy English battery continued to fire when our men were already within 100 yards of its guns. Finally the gun crews jumped to some machine guns which were in position for defence at close quarters, and blazed away till overcome by our storming columns."

If the retirement continues, even the Heavies will have to withdraw to fresh positions. And so the defence proceeds, taking heavy toll of the attack at each stage, till the attacker's reserves are exhausted, or till he has to pause to make fresh roads, bring up his heavy guns, and start afresh.

When, by the process of attrition of the attacking force, the defender becomes the stronger, he attacks in turn. This has happened before during the war, and will happen again.

Victory will be to the side that has the will-power to endure longest.

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COMPARATIVE CALIBRATION IN THE FIELD.

By Major C. Q. L. Penrose, M.C., R.G.A.

As the subject of calibration is one very frequently discussed by junior officers, and as there seems to be considerable doubt as to the simplest method of setting out a comparative calibration, the following notes on a method which I have always used with satisfactory results may be of use, especially to those who have during instruction become confused by the bogey of "reduction to Normal", and by the substitution of various rules of thumb for the precepts of sound common sense.

In the first place it must be realised that all that can be reasonably expected in the field is a comparison between the M.V. of your gun as laid down in its Range Table and the M.V. at which it is actually firing; and that no two guns, when new, ever shoot alike.

It is therefore of the utmost importance to get some idea of how a new gun is shooting, and not to imagine, as I have found some officers imagine who ought to have been taught better, that if a memo of exam. shows no rounds fired, the loss of M.V. will be $\pm$ O on the R.T. value.

There are three principal methods of observing a calibration in the field.

1. By cross or triple observation, and the determination of an M.P.I. from a series of rounds *fired at the same line and elevation*, the fall of each of which is plotted on a grid.

2. By ranging on to a suitable object by means of single line ground observation.

3. By ranging on to a suitable point by means of aeroplane observation. Of these methods 1 if done properly is by far the most satisfactory, but a series of at least 10 rounds, and if practicable 20, must be fired, exclusive of "creeping" rounds used in bringing bursts into the field of view of the instruments. It is advisable in this connexion to add an arbitrary correction to the calculated initial elevation before beginning the series, according to the number of equivalent full rounds fired up to date as shown on the memo of exam. In this way "creeping" rounds can usually be avoided altogether.

Only a small modification in the pro-forma used is necessary when using this method, and it must be remembered that when finding the distance of the M.P.I. from the target, only the rounds fired at the same line and elevation must be used for averaging purposes.

Before discussing the pro-forma there is one point which must be made clear and that is the correct method of obtaining the correct

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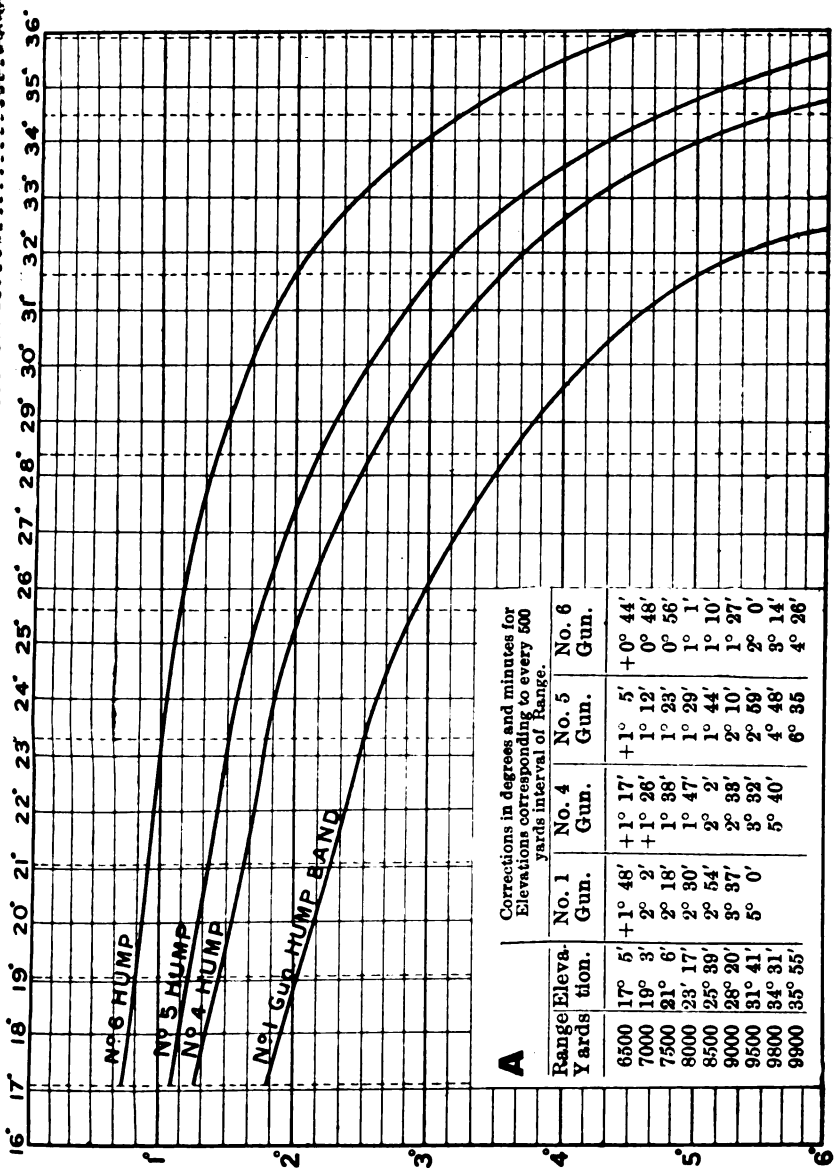

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Range Yards	Elevation.	Corrections in degrees and minutes for Elevations corresponding to every 500 yards interval of Range. No. 1 Gun.	No. 4 Gun.	No. 5 Gun.	No. 6 Gun.
6500	17° 5′	+1° 48′	+1° 17′	+1° 5′	+0° 44′
7000	19° 3′	2° 2′	+1° 26′	1° 12′	0° 48′
7500	21° 6′	2° 18′	1° 38′	1° 23′	0° 56′
8000	23′ 17′	2° 30′	1° 47′	1° 29′	1° 1′
8500	25° 39′	2° 54′	2° 2′	1° 44′	1° 10′
9000	28° 20′	3° 37′	2° 33′	2° 10′	1° 27′
9500	31° 41′	5° 0′	3° 32′	2° 59′	2° 0′
9800	34° 31′		5° 40′	4° 48′	3° 14′
9900	35° 55′			6° 35	4° 26′

value in yards of 5 minutes at any range. The Column headed "*5′ Elevation alter point of impact*" should *not* be employed, but the value of 100 yards in minutes for the 100 yards on either side of the range used should be taken and averaged, and the value of 5′ in yards obtained from this by simple proportion. By using the "*5′ elevation*" column it is quite possible to get an error of 5 foot seconds or even more in some parts of the Range Table for a fairly worn gun.

The pro-forma shown here eliminates all but essentials, and, I think, reduces the calculations to their simplest form. It is filled in to

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give a complete example of a calibration for a 6″ How. 26 cwt. using 4th charge. Having obtained the loss of foot seconds of M.V. from the normal as shown in the Range Table, it is necessary to compile from this value a table of corrections corresponding to every degree of elevation throughout the useful range of the charge used.

This should be done by tabulating the values of corrections at elevations corresponding to each 500 yards through the Range Table, which can be done without any interpolation in the column headed "*10 f.s. variation in muzzle velocity*", plotting these values on a graph, (shown in Table A, inset) and reading off values for every degree (shown in Table B) from the curves so constructed.

These M.V. corrections will then be applied to initial elevations *after* including all initial corrections.

B

Elevations.	Corrections in degrees and minutes for every degree of Gun Elevation.			
	No. 1 Gun.	No. 4 Gun.	No. 5 Gun.	No. 6 Gun.
°	° ′	° ′	° ′	° ′
17	+ 1 47	+ 1 16	+ 1 5	+ 0 43
18	1 54	1 21	1 8	0 46
19	2 2	1 26	1 12	0 49
20	2 9	1 32	1 18	0 52
21	2 17	1 38	1 23	0 55
22	2 23	1 43	1 27	0 58
23	2 28	1 47	1 31	1 1
24	2 35	1 51	1 35	1 4
25	2 45	1 57	1 40	1 7
26	3 0	2 6	1 47	1 11
27	3 14	2 16	1 56	1 16
28	3 30	2 28	2 6	1 23
29	3 48	2 43	2 18	1 31
30	4 10	3 0	2 32	1 40
31	4 37	3 18	2 47	1 50
32	5 20	3 41	3 11	2 5
33	7 45	4 12	3 39	2 26
34		5 0	4 18	2 56
35			5 10	3 34
36			6 50	4 30

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Gun 6 Reg. No..... Charge 4 (N.C.T. 6) Driving Band. HUMP No. of Equivalent full Rounds fired to date 1560

Map Sheet..... Battery Position..... .... O. P. Position. 1..... 2..... 3.....

Position of Target..... Grid Bearing of Target from Battery 80° Date 2.5.18 Time 3.0 p.m.

Barometer 30·02" Air Temp. 54° F. Charge Temp. 60° F. Wind 10 from 120° Range 9085 yards 5' Elevation = 13·5 yards.

Map Line 125° 30' Left.
Wind (Defln.) 0° 5' more Right
Initial line 125° 25' Left.

* Hitting Line 125° 30' Left. Difference 5'

	yards.	Elevation.
(Fuze 106) RTE. ? ...	9085	29° 9'
A. Barometer ...	+ 3	
B. Air Temp. ...	+28	
C. Charge Temp. ...	± 0	
D. Wind (Range)	+67	
Sum of A, B, C, and D	+98	+ 0° 36'
Angle of Sight ...		+ 0° 13'
Initial Elevation ...		29° 58'

‡ Hitting Elevation 31° 30' Difference 1° 32' = 250 yards = Loss of 37 foot seconds M.W.

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* When using Method 1, substitute: "Line correction to bring Bursts into Field of View ± Lateral distance (angular) of M.P.I. from Line of Fire = ° ' R. or L.

‡ When using Method 1, substitute: "Elevation correction to bring bursts into Field of View ± Difference in yards converted to difference in elevation, between M.P.I. and Target = °

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DRIFT WITH THE 4·5" HOWITZER.

By Major L. E. Booth, M.C., R.F.A.

BEFORE 1914 drift was compensated for by an automatic drift cam in the carrier. I am assuming the correction made by this cam to be correct, and therefore equal to the actual angular drift of the shell at any given Gun Range.

During the war it was found that these cams gave trouble and it was decided to do away with them. It was then necessary to provide another means of compensating for Drift, this was done by inclining the Sight and Carrier at 4° to the Vertical. This causes the line of sight through the dial sight to diverge from the line of the axis of the piece as range is put onto the gun. This gives a certain amount of compensation for drift, actual figures are given below.

Range.	Actual Angular drift of Shell equal to Amount compensated for by Drift Cam.	*Amount Compensated for by having Sight Inclined at 4°	Difference.	
1000	9′	15′	6′	Too large a compensation
2000	21′	36′	15′	
2500	29′	48′	19′	
3000	38′	1° —	22′	
3500	51′	1° 13′	22′	
4000	1° 8′	1° 28′	20′	
4500	1° 31′	1° 45′	14′	
5000	2° 15′	2° 9′	6′	Too small a compensation
5100	2° 28′	2° 15′	13′	
5200	2° 42′	2° 23′	19′	
5300	3° 5′	2° 33′	32′	
5400	3° 39′	2° 48′	51′	

* These figures were only taken in the Field and their accuracy is not guaranteed.

From the above figures it will be seen that up to about 4750 the compensation (by the 4° idea) is too large—above 4750 it is too small. The correction for drift is a Left Correction, since the shell drifts towards the Right, and therefore in order to be quite accurate we need to put on a correction equal to the column of differences—More Right up to 4750 and More Left above 4750.

But this is not quite the end of the matter. I take it that most B.C's. finally establish their line by registration. Supposing a B.C.

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has a gun with sight inclined at 4° and makes no allowance for it and registers his datum point at say 3500 Gun Range—he then plants aiming posts and calls that his zero line—(it is really a false zero line 22′ too much to the right).

Now suppose he wishes to engage another target at a Gun Range of say 4750 if he makes no correction he will find his shells are falling 22′ to the right of his target—supposing this target had been at a Gun Range of 5300 he would be 54′ (22′ + 32′) to the right of his target.

Considering that nowadays a great deal of shooting is done blind—and also that 4·5 howitzer targets are very frequently targets where accuracy of line is vital—it seems to be most important that some correction should be made for guns that have no drift cam and whose sights are inclined at 4° to the Vertical.

For the purpose of this acticle I have assumed that the actual Angular Drift of the Shell at any Gun Range is equal to the angular compensation caused by the Drift Cam when new.

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RANGING ON THE LINE OF OBSERVATION without the use of Factors.

By Bt. Col. A. ff. Powell, D.S.O., R.A.

RANGING on the L. of O. as laid down in the Training pamphlet appears to have fallen somewhat into disuse, and a more complicated and lengthy method of dividing the ground about the Target into Sectors, to have taken its place.

The features of the ground in the vicinity of the Target are when distinct enough, a great aid; but need not prevent the Ranging consistently following a fixed principle.

Ranging on the L. of O. may be conveniently divided into two parts:—

(1). Finding a mean point of impact on the L. of O. at any point not too far from the Target.

(2). Bracketing the Target on the L. of O.

With regard to (1)—

When a gun being kept in the same line and at the same elevation has got two rounds right and two rounds left of the L. of O. a mean point of impact on the L. of O. has been found. In other words the 1st process is to bracket *across* the L. of O. the gun being kept in the same line.

With regard to (2)—

As the position of this mean point of impact (found as above) with regard to the Target is not known further than it is, either − or + on the Oberver's Line. The Targe must now be bracketed on the L. of O. The use of the Ready made Scale in the Field Message Book renders this a quick and easy process. Keep a few pages of the Field Message Book with two blue lines accentuated as in Diagram, and assume the Target to be at the Junction of these Lines.

Set off the Apex angle from T, BT being the Line of Fire of the Battery. Assume P to be the mean point of impact on the Line O.T. obtained as in (1).

The Observer has now to decide (as in ordinary ranging) what size Bracket he will require to place his next round on the other side of the Target from O. Say he employs a bracket of 80′ elevation, and that on referring to the Range Table he finds this gives him an increased Range (at the Range he is firing at) of 180 yards.

Taking the sides of the squares as 20 yds. this gives the fall of his next round at E, 9 squares up from P, and to keep on the L. of O. (see Diagram) he must, in the case of an Apex angle of 20° give Deflection for 70 yds. (3½ squares) in the case of an apex angle of 60° 300 yds. (15 squares).

The amount in minutes of Deflection is easily computed either from the Range Table or more quickly by the "2° Method".*

The values found can then be halved or doubled for smaller or larger brackets.

*2° always gives a Deflection in *feet* equal to $\frac{\text{Range in yds.}}{10}$

NOTE. Keeping a few pages of the Field Message Book with two lines accentuated as in diagram, is a great time saver for many of the little problems that occur in the Field. Resolving, Wind, Compass Bearings, and other problems that can be done quicker by diagrams than by calculation.

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THE LONG RANGE GUN.

A Lecture delivered at the Royal Artillery Institution, on Monday, 13th May, 1918.

BY MAJOR J. MAITLAND-ADDISON, R.A.

Brig.-Genl. A. Stokes, C.B., C.M.G., D.S.O., Commanding the Troops, Woolwich, in the Chair.

THE CHAIRMAN: Ladies and Gentlemen: I have much pleasure in introducing the Lecturer, Major Maitland-Addison who is to talk to us about the Long Range Gun. I have no doubt that it will interest us very much indeed, and I will ask him to get on with his lecture. (Applause).

MAJOR J. MAITLAND-ADDISON: General Stokes, Ladies and Gentlemen: We read that the German Long Range Gun has been aptly nick-named by the French 'La Grosse Berthe'. Two other appelations which I am told are used, one of which is very appropriate even if the other is a little more expressive, are 'La Princesse Lointaine' after one of Rostand's plays and,—'l'Imbécile'. Our gallant French Ally would thus appear to be contemptuously indifferent towards the attentions of this monster weapon—the 'Super Gun'.

However, a marked advance has been made in artillery,—for a projectile has been thrown a distance four times greater than has ever been previously attained. It is my purpose to explain in as simple a manner as I can, the various factors which co-operate towards this achievement,—and further to point out that there is nothing about this gun which differs except in degree, from the ordinary gun,—that is to say,—no new discovery has been made which *per se*, has enabled the enemy to effect what he has just accomplished in this respect.

On the 23rd March—Palm Sunday—the Parisians were much astonished by a bombardment of Paris which lasted throughout the day. At first it was thought that bombs were being dropped from enemy aeroplanes—but this idea was soon dismissed for none were to be seen, although the bombardment continued. The conclusion was then arrived at, that such a range as the distance between the German Front and Paris, had been obtained by a powerful gun, but

My acknowledgements are due to Captains L. Benke and F. Hunt, of the Ordnance College, for their assistance in the calculations entailed, and in the preparation of the Plates.

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only by the projectile itself becoming a gun at some point of its trajectory, and ejecting a secondary shell to complete the great distance of 75 miles.

This, and many other quaint ideas were hazarded one after another,—to be eventually dispelled by the more technical experts, who gave the real reasons which lead up to such a feat.

It must be remembered that in 1915, the Germans caused us no little surprise by firing shell into Dunkirk from Dixmude—a distance of 20 miles,—and since then a considerable amount of long range firing has been carried on at the Front. But in 1918, the unprecedented range of 75 miles is an accomplished fact. This is only in keeping with the progress that has been made in artillery during the war. War makes for progress,—and I will leave it to my audience to surmise what will be the extreme distance to which shell may possibly be projected in 1921, assuming the rate of increase to be, at least uniform.

My lecture is what may be called pseudo-scientific-popular, because, although I mean it to be popular, it must be to a certain extent scientific; otherwise, I should have some difficulty in explaining the factors which conduce towards firing shells to such great distances.

I have divided it into the various subheads which would appear to me to form the logical sequence of the subject.

The Air Resistance to Projectiles.

Fig. 1.

I must first introduce to you some conceptions of what an important factor the air resistance is to projectiles in retarding their motion. We all know something about the atmosphere and its resistance to motion, but I think that few of us have more than a very cursory knowledge of how resisting it is to projectiles moving at high velocities. There may be a few here who have at some time or another been whirled round the Brookland's Motor Track at speeds approaching to, but probably under 100 miles per hour, and who consequently will have gained some experience of the pressure of the air as they rushed through it; and we know that racing cars are in some cases stream-lined in order to diminish the air resistance.

Also when travelling on the Paris Lyons et Méditerranée Railway to the South of France, many will have observed that the locomotives are fitted with 'wind cutters' for the same purpose. The natural inference to be deduced is, that even at velocities of 100 miles per hour or under, the air offers such a great resistance, that it is desirable to take advantage of such means as can be devised to reduce it, even if the reduction effected be small. Now these velocities are comparatively low ones. The projectile of to-day, moves at high velocities. To illustrate the difference, the projectiles at present being fired from the German Long Range Gun commence their flight at about 1 mile per second or 3600 miles per hour. Fig. 1 represents a hypothetical curve of the air resistance to what is termed the 'Unit Projectile' of 'Standard Shape'—that is a projectile of 1-inch diameter with an ogival head of 2 calibres radius—for velocities up

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to 10,000 feet per second, or about 2 miles per second. This curve is based on what is called a 'quadratic law' of resistance, that is to say, the resistance increasing as the square of the velocity.

Along side it, the dotted line represents our experimental knowledge of the air resistance to the same projectile. As you can see, this does not, at present, extend beyond velocities of 4,000 feet per second. The two curves agree at two points only, and until we have experimented at higher velocities, thereby extending the knowledge that we possess, it is necessary, for the purpose of calculating these long range trajectories of the future, to make use of a hypothetical curve similar to that illustrated, working on the principle that such a law is in conformity with the ways in which nature presents itself to us in other respects,—these are well known to the scientific world. An examination of the curve shows that for the 'unit' projectile moving at 4000 f.s. the air resistance is about 50 lbs.—or nearly 50 times the weight of the projectile which is normally about 1lb; for a velocity of 8000 f.s., this resistance is increased to about 200lbs., and so on.

To ascertain the resistance to any other projectile of different diameter and shape, we have to multiply the figures shown on the curve, by the square of its diameter and by a suitable coefficient of shape.

Thus for a 10-inch shell of standard shape of head, moving at 4000 f.s. the resistance is 5000 lbs., or only ten times the weight of the shell. If we give the shell a much more pointed head,—that is to say,—strike the curve of the head with a radius of, say 8 calibres, the resistance at the same velocity now becomes 2500lbs., so that it has been reduced by 50%. A table of such coefficients of shape is inset in Fig. 1. This pointing of the head corresponds to the 'wind cutter' on the locomotive, and at such high velocities as projectiles move at, it is mainly the shape of the head that is important.

Diminution of atmospheric density as the altitude above the earth's surface increases.

If the density of the air were uniform throughout, implying a total height of about 30,000 feet the resistance to projectiles about which I have just been speaking would always be so great that such super-ranges as are now being obtained, would be beyond all our efforts, even for very high velocities of projection. But it is a fact that the density diminishes very rapidly with the altitude above the ground and consequently the resistance offered by the air becomes so reduced, that as the projectile ascends, its motion becomes less and less affected, and so, in the extreme case, such as we are considering, it tends to travel as if in a vacuum.

At the ground, the density is proportional to the pressure exerted by the weight of a vertical column of air, reaching to the upper limit, which is equivalent to the weight of a column of mercury 30 inches in height, the pressure being about 15lbs. to the inch—and the density is then about 534 grains to the cubic foot. or a little more than the fourteenth part of a pound avoirdupois. If we assume that the atmosphere expands upwards according to what is known as the

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Adiabatic Law, which allows for the diminution of temperature with altitude, we should arrive at the conclusion that it terminates somewhat abruptly at a height of 17 miles. On the other hand, assuming that the expansion follows an Isothermal Law—that is, expands at a uniform temperature,—we are led to the consideration of an atmosphere of infinite height. But we are practically certain that there is a very much rarefied atmosphere at heights of 50 miles and more, as indicated by meteorites glowing red hot owing to the resistance to their motion—their velocity being very considerable. Equally well, our 'physical' knowledge tells us that the height cannot be infinite. The present view is that the expansion follows the first law in the lower strata, and tends towards the second in the higher and more rarefied region. Both laws do not differ much in the estimated density of the air up to a height of 30,000 ft. or about 6 miles,—moreover up to this point, theory has been largely confirmed by experiment. The air is then getting so rarefied that, as far as a projectile of reasonably high ballistic efficiency is concerned, it is not very material as to which of the two above mentioned laws is nearer the reality.

I have followed the Isothermal Law in my calculations, as it does not favour the estimated range. On this law the density at 20,000 ft. is about one half its value at the ground, one quarter at 40,000 ft., one ninth at 60,000 ft., one eighteenth at 80,000 ft., and at 100,000 ft. or about 20 miles, it is only one thirty-sixth—so that at such a height each cubic foot should contain about 15 grains only of air, as compared with 534 grains at the ground.

This is illustrated in Fig. 3, by the shaded column. You will now appreciate how very much the resistance is diminished at such great heights. It is this diminution of density in the upper regions of the atmosphere which alone, allows the projectile to travel unimpeded, thus giving such a great range as 75 miles.

The ballistic efficiency of a projectile.

I must now mention an important feature in connection with projectiles, that is, their 'ballistic efficiency,' or what we call in Gunnery their 'ballistic coefficient'. If it were not for the atmosphere, a ping pong ball would travel as far as the heaviest projectile, given the same initial velocity. But in an atmosphere, this statement is far from the truth. A ping pong ball would soon come to rest, and this is, because it has poor ballistic efficiency—therefore no power to force a path for itself through the air, on account of its bad shape and light weight for its size.

The modern elongated projectile with long tapering head has great ballistic efficiency, because of its good shape and heavy weight for any given diameter.

Then, if we give it a sufficient initial velocity, and project it from a gun at a high angle of elevation, it will reach the upper strata of the atmosphere—and as the air becomes rarefied, so in proportion does the ballistic efficiency increase. For any given calibre of well designed projectile, there is a certain height above the ground, at which point, the effect of the air resistance becomes negligible, and

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aining Velocity

- - 50°.

- - 54°

VEREST 51 Miles.

45

ING CURVATURE.

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the ballistic efficeiency for all practical purposes, infinite. The projectile will then travel in the parabolic curve first pointed out by Galileo about 1610. This is what is happening in the case of the German Long Range Gun, and throughout the major portion of the trajectory, the projectile is describing this path as an actuality, for the first time.

One rather curious fact concerning the shape of the head of projectiles:—important factor as it is, it has been generally neglected by all the artilleries of the world up to within the last 10 or 12 years, although the advantage of the long pointed head, had been indicated from mathematical consideration with very fair accuracy, many years previously.

Comparison of Long Range Trajectories.

Fig. 2.

Fig. 2 represents the comparison of the 20 mile trajectory of 1915, with the 75 miles of 1918 of the latest Long Range Gun, also the limiting trajectory in vacuo, for the same velocity, and for the same angle of projection, as for the 75 mile trajectory. These two factors, I have estimated to be 5000 feet per second and 50°. From what we learnt about it at the time, the 20 mile trajectory from Dixmude to Dunkirk was accomplished with a large naval gun and with a much lower velocity than 5000 f.s. The ballistic efficiency of the projectiles at present fired into Paris is about 10 units, which is somewhat high for such a small calibre of gun as 210 mm. or 8·28 inches. By employing guns, for which the projectiles could have a greater ballistic efficiency, then with the same velocity, ranges of more than 100 miles could be obtained. Proceeding in this way we could, for the same initial velocity, get nearer to the limiting trajectory of 146 miles,—but never quite up to it. But by increasing both velocity and ballistic efficiency, greater ranges than this even, are obtainable.

Such a velocity as 5000 feet per second has not, to my knowledge, ever been obtained before. The greatest I know of is that of 4000 f.s. from a small gun at Shoeburyness in 1904 when the Ordnance Committee were re-determining the air resistance to projectiles. The late Sir Andrew Noble—some 30-40 years ago—obtained velocities of about 3200 f.s. out of a 6-inch gun, but this figure does not even compare with the high velocity of the German Gun. We therefore see how great is the advance that has recently been made in this respect.

The Trajectory of the Long Range Gun.

Fig. 3.

In Fig. 3, are shown the details of the trajectory for a range of 76 miles, which is slightly in excess of that from the Forêt de St. Gobain to Paris. The angle of projection has been taken as 50° but more correctly I think it should be about 54° for this particular gun. The angle for maximum range,—which is 45° in vacuo,—is greater in the case of these long range guns, which have to force

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projectiles into the upper rarefied strata of the atmosphere. It varies according to the initial velocity and ballistic efficiency of the projectile, and tends to return to 45° as these two factors increase in magnitude,—the principle involved being, that it is necessary to get the projectile into the more rarefied region by the shortest path, and further, that the flight in this region should commence at about 45°.

As previously stated, the initial velocity is 5000 f.s. or just short of 1 mile per second. The projectile rises to a height of 12½ miles in 25 seconds,—the inclination of the trajectory changing from 50° to 41°—the horizontal advance being also about 12½ miles. At this point, the air density, as indicated by the shaded column has diminished to about $\frac{1}{10}$ th of its value at the ground, and the ballistic efficiency of the projectile, which is 10 units at the ground, has, vice versa been increased 10 times,—that is to say it is now 100 units. From this point the projectile practically ignores such slight air resistance, as there may be in the region above it, and its motion becomes parabolic to a point at the same level on the descending branch, the horizontal distance to which is about 65 miles from the gun. Thus 52½ miles or about 70% of the whole trajectory lies in what may be termed the Parabolic Region of Flight. The projectile passes through the vertex at a height of 23·9 miles, the horizontal distance to the vertex being about 39 miles, or just over one half the range.

I might mention that in 1862, two celebrated and intrepid aeronauts Coxswell and Glaisher ascended in a balloon from Wolverhampton, to a height of about 37,000 feet or 7 miles—the greatest known height ever reached by man,—and narrowly escaped with their lives, on this occasion. To Glaisher we owe much of our knowledge of the physical characteristics of the atmosphere, and his tables have been in use in the 'Artillery' for many years. An aeroplane has never been higher than 4 miles, and Mount Everest, the highest point on the earth has an altitude of 5½ miles, so that these comparisons will enable you to appreciate the great height attained by the projectile.

On the descending branch, the velocity which is reduced to 2267 f.s. at the vertex, commences to increase rapidly, attaining its maximum of 3088 f.s. at 7½ miles from the ground, and at about 6 miles from the point of arrival It then diminishes owing to the rapidly increasing air density, and the projectile finally reaches its destination at a velocity of 2626 f.s.—about 2½ times the rate at which sound travels,—there is therefore no possibility of anyone hearing it coming, even for the fraction of a second. It will be seen therefore that in determining the trajectory, the air resistance has to be taken into account at the two ends only. To quote Sir George Greenhill, F.R.S. so long associated with the Royal Artillery in his capacity as Professor of Artillery and Mathematics at the Ordnance College, Woolwich, the trajectory may be considered as being on two stilts, and it is on these stilts that we have to give careful attention to the exactitude of our calculations. The angle of arrival on a tangent

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to the earth through the gun is about 54° 40′, which is only a little greater than the angle of departure,—and allowing for the earth's curvature which is considerable over a 76 mile trajectory, another 1° 6′ has to be deducted from this figure, so that actually it is about 53° 34′.

Subsidiary problems in connection with the trajectory.

There are several subsidiary problems which I will briefly mention. Some of these,—hitherto negligible—now assume importance in these long range trajectories.

Earth's Curvature:—

You will have noticed for instance in Fig. 3, that account has been taken of the Earth's Curvature, which in this case adds ½ mile to the range. This correction is now very much of account, as it varies as the square of the range.

Diminution of Gravity with Altitude:—

For a trajectory of the height in question, that is, 24 miles, the acceleration due to gravity at the vertex is diminished about 1 per cent. This would have to be allowed for in calculation, were it not that an almost exact compensation is provided by ignoring another effect, namely the convergence of the "parallels of gravity" towards the Earth's Centre.

Earth's Rotation:—

This is also responsible for a correction to either the direction of the shooting—or to the range—or to both,—according as the direction of the fire is from Pole to Pole,—Parallel to the Equator,—inclined to both—also this correction is dependent on the latitude at which the firing is being carried out.

I have estimated that unless such a correction be applied in the case of the gun firing into Paris—the direction of fire being about South West and the Latitude 50°,—there would be an excess of about 700 yards of range, and a deviation to the right of the Line of Fire of about 400 yards.

Drift:—

As Artillerymen, we know what 'Drift' it, but I will just mention that it is the deviation to the right from the vertical plane of departure due to the right handed rotation of the projectile. I have not attempted to calculate how much this drift is, because it is a matter of great difficulty, and the result arrived at would be uncertain, but I will say this much about it. I think it is much less than a Gunner might be pre-disposed to imagine, for the reason that 70% of the trajectory is accomplished practically in a vacuum where there is no appreciable atmosphere to cause it—and such 'drift' as there may be, is due to the comparatively small curvature of the trajectory in the two 'stilts'. If I were asked to hazard a guess as to its 'How Much', I would say that I think that it would be less than 1 mile of deviation

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in 100 miles of range. However this is guesswork, and it is really a matter of experiment to ascertain its magnitude.

Accuracy of the Gun:—

A small error in the elevation for maximum range, would not appreciably affect the range, so that a little 'Jump' or 'Whip' of the gun is of no great importance. But a varying error in the muzzle velocity from round to round, if it be large, vitally militates against the accuracy,—and there is just a possibility that it may be difficult to maintain a constant M.V. in such a gun. For example 100 f.s. or 2% change in M.V. alters the range in this case by over three miles.

Wind Effect:—

Here again I have not made any estimate, but arguing on the same lines as for the 'Drift', I do not think, it should be very great.

I will now pass on to some considerations of the projectile and the gun.

The Projectile.

Fig. 4.

The shell presents features that are distinctly novel. In the first place it is built up, instead of being made as a whole: in this way, manufacture and filling are much facilitated. Secondly, it is divided into two principal parts, entirely different in characteristics and functions. These are:—

(a). The body or shell proper.
(b). The head.

The body:—

The walls of the shell are abnormally thick, tapering towards the front where the danger of deformation due to 'set back' diminishes. This is an indication that the pressure to which the gun is worked is in all probability greater than usual, but it also serves another purpose—one that is evident in the entire construction of the shell,—and this I will refer to later. The function of the two copper bands AA is that of centring and steadying the shell in the bore, and of effecting the gas seal. Since they take the rifling, they indirectly assist in rotating the shell, but this is not their 'métier'; and to effect this, the shell itself is rifled which is a reversion to old practice. Rifled projectiles were used by ourselves many years ago, but the design was naturally more crude. The thrust of the rifling of the gun on the shell, in imparting the necessary rotation for stability of flight, is thereby much more evenly distributed along the shell, and failure to rotate, which might result if the two copper bands were alone called upon to do this work, is thus eliminated.

Assuming a maximum working pressure of 21 tons/in^2, the acceleration of the projectile at the point of maximum pressure is about 250,000 feet per second, which is enormous and consequently the 'set back' pressure is unduly high.

The diaphragm B increases the strength of the shell, and by dividing the bursting charge into two parts, lessens any risks there

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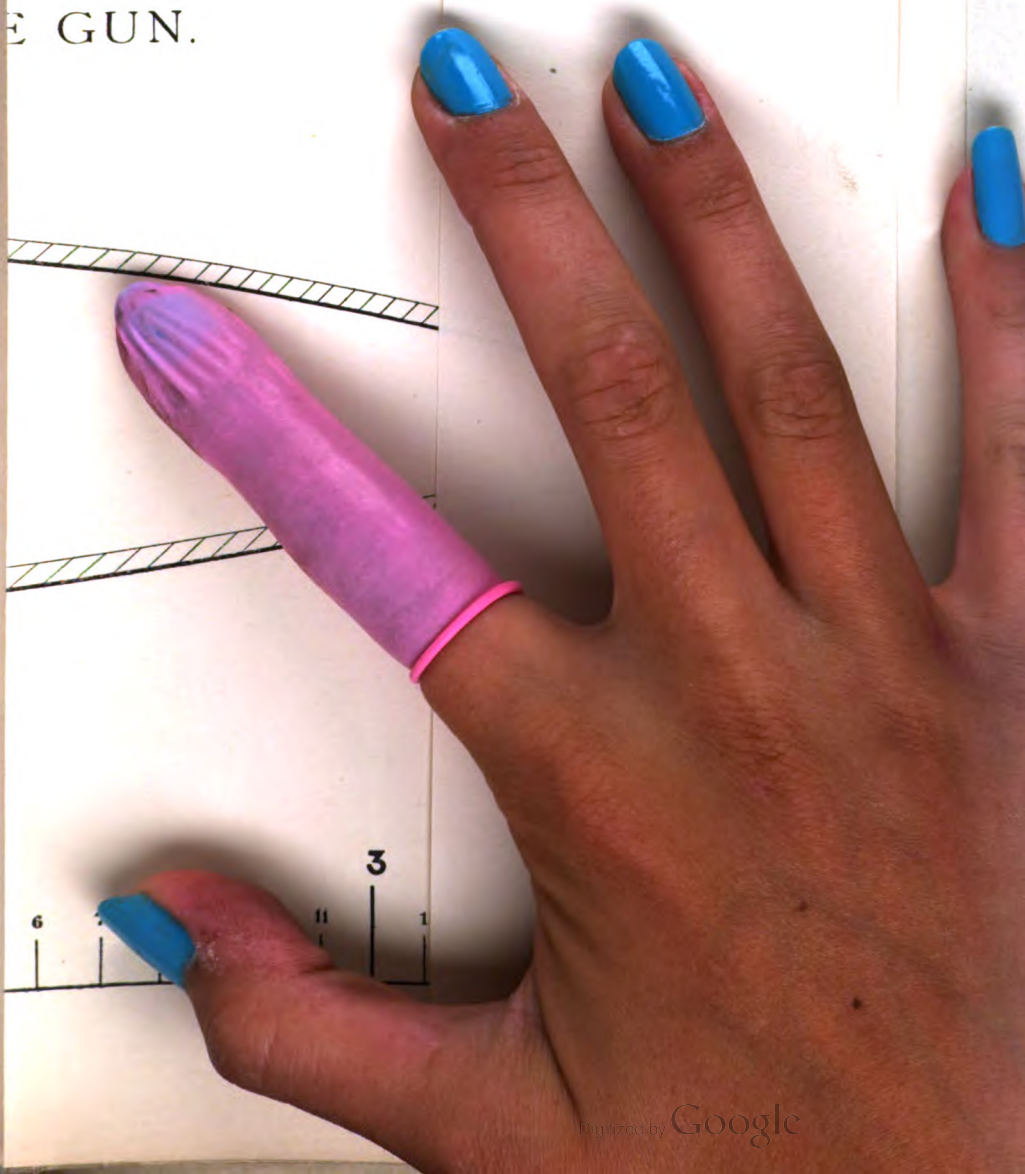
eight. 330 lbs.

E GUN.



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might be due to the 'set back' of the explosive towards the base. It is understood that it is also called upon to support an additional 'impact' fuze inside the shell, which tends to obviate all possibility of 'blinds', and serves to ensure the bursting of the forward compartment. It appears to me that this last mentioned function, is its real 'raison d'être'. The screwed socket C also holds a base impact fuze.

The capacity for high explosive is small, and the burster would weigh about 33lbs., or 10% of the weight of the shell. With such thick walls and a small burster, the projectile would break up into a few large pieces, the resulting damage, in all probability being small.

The Head:—

A curious feature, although not entirely novel, is the false head, which is screwed on to the body or shell proper. It is a comparatively thin pointed steel dome, and I should say, is struck with a radius of about 10 calibres. I have assumed such a radius in estimating the ballistic efficiency of the projectile. I am not aware if the head has been 'reconstructed' from parts which may have been found, so that this value is hypothetical, although a reasonable one. The function of this head is to diminish the air pressure, as I have previously explained, but it also serves another purpose,—that is to throw the centre of pressure well forward of the centre of gravity,—a principle which, given the requisite twist of rotation for stability, increases the steadiness of the projectile during flight. The analogy of the peg top and the teetotum serves us here. Given the requisite spin, the peg top in which the C.G. is situated high up, is much steadier and maintains its steadiness, better than the teetotum in which the C.G. is low down near the point. The pressure on the head of the projectile when leaving the gun is about 1 ton, and the head must be strong enough to withstand this pressure. There is one more point which I might conveniently mention here—and that is this. In a vacuum, a rotated projectile would travel on its path, in the same relative position to that at starting, and its axis would become more and more oblique to the trajectory. The presence of air resistance, causes a rotated projectile to keep its point nearly in the trajectory. Hence although the air must be very rarefied in the upper part of the trajectory which I have described, yet there must be sufficient resistance to keep the 'yaw' within limits, until on descending again into the denser strata, the projectile becomes steadied, otherwise it would become quite unstable, the result being 'blinds' and short ranging. This I believe, not to be the actual case.

The rifling on the shell indicates a slope of 4° or a uniform rifling in the bore of 1 in 45 calibres. Such are the main features of the projectile.

The Gun and its Mounting.

Now we know nothing of the type of gun the Germans are using, except its calibre: nor do we know how it is mounted for firing. But by employing another branch of artillery science called 'Internal Ballistics' we are able to form a fairly accurate estimate of its length, charge, capacity, pressure, etc. The principles of gun

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construction can then be applied to determine a gun which will furnish the requisite strength and we are then in a better position to deduce what type of mounting or carriage might be suitable, and form a mental picture of the whole.

The Gun:—

One or two of the Illustrated Journals have depicted in bold lines, the gun on a railway mounting. An examination of these pictures shows clearly that they fail to represent with any degree of accuracy what the dimensions of a gun must be that can discharge a projectile with a velocity of one mile per second. I have therefore worked out the ballistics and dimensions of a gun which would be equal to doing this—represented graphically to scale in Fig. 5. I have assumed a maximum working pressure of 21 tons to the inch, which is some two to three tons more than a gun is usually worked to. Supposing that it were possible to maintain a constant pressure of this magnitude, all the way down the bore,—it is a matter of very elementary dynamics to estimate that the length of the shot travel alone,—that is of the rifled portion of the bore,—would be 50 feet. Now no one has yet invented a system by which a constant pressure can be maintained, and as the gases of the charge expand, the pressure drops considerably towards the muzzle—down to less than one half of the maximum. I have estimated, by the more elaborate methods of "Internal Ballistics", that for such a maximum pressure as I am considering, the shot travel must be 75 feet the average pressure being 15 tons, and that at the muzzle about 8 to 10 tons to the inch. Add to this figure, a minimum length of chamber of about 15 feet necessary to hold the very large charge of propellant required, and the total length of the gun comes to 90 feet, or about 130 calibres of length,—a length in calibres not previously approached except by Sir Andrew Noble's experimental 6-inch gun of 100 calibres. The weight of a gun is dependent on design, besides considerations of the requisite strength,—but following the usual methods laid down for gun construction, it would work out at about 80 tons, for such a gun.

The amount of propellant required is about 400 lbs., which is considerably in excess of the weight of the projectile, and if a cord propellant is used, its diameter would be 0·6 inches. It is possible that some form of multitubular propellant may be employed by the Hun, which would tend more towards giving the constant pressure I have previously mentioned, and thereby slightly diminish the length of gun required, but this decrement would be very small. As regards the life of the gun, it has been said that such guns would be very soon worn out. I do not hold this view. With a working pressure very little above that normally used, the life of the inner tube should not be much short of the normal life of an ordinary gun of the same calibre, and I think it is quite possible that this particular calibre of gun may fire 600 to 700 rounds before requiring to be relined.

It has also been suggested the Hun may be using a big gun lined up to a smaller calibre, to effect his purpose of Shelling Paris. Such a measure would not give the ballistics for a 75 mile range—and

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I am inclined to the view that the gun has been specially constructed for the purpose. Manufacturing difficulties are to some extent increased; also special plant is required. These difficulties are not insuperable as is evidenced, and although gun design has been very much standardized, it is quite possible that newer methods of construction will be evolved which will facilitate manufacture.

The Mounting:—

I have pictured the gun as being mounted on a very ordinary type of standing carriage, erected over a deep excavation in the ground for it is quite inconceivable that a gun of such length could be fired at the correct angle of elevation, from any form of railway mounting, or even from a long elevated bed of concrete, which has also been much discussed as being the only feasible arrangement.

The gun could be more easily transferred from its travelling position on railway trucks, to this type of mounting. It is also practically certain that it has to be brought to the horizontal position for loading. It is not possible to say whether any arrangements exists for traversing. Having regard to the target at which the gun is being fired,—also the range—very little traverse is required. One degree change in direction means a displacement of the Point of Impact of nearly one and a half miles Right or Left. At the same time, it would be feasible to arrange for a small degree of traverse, although possibly not an easy matter.

The Recoil:—

The Energy of Recoil is greatly subnormal on account of the great weight of gun and recoiling parts, relative to that of the shell. In this case the ratio is between 600 and 700 to 1 as compared with the more normal ratio of 120 to 1 in most guns. Therefore the Recoil arrangements do not call for any remarks.

The ultimate limit of velocity.

Fig. 6.

This illustration shows the effect of increasing the velocity up to what,—for want of a better term, I call the 'ultimate limit,'—which is to throw projectiles off the Earth into space,—such a feat as Jules Verne had in his mind when he wrote his book "De la Terre à la Lune". The requisite velocity is not so immeasurably higher than has already been achieved to-day. A velocity of a mile per second has been obtained: assuming that some day we may be able to increase this to five miles per second (a velocity only five times greater), and the projectile would then travel round the Earth as a grazing satellite, completing its orbit between seventeen to eighteen times daily. And with a still higher velocity of about 7 miles a second, it would move off into space never to return. But it must not be pre-supposed that the dimensions of the gun are merely in simple proportion to the velocity, it is required to produce. On the contrary, they increase as some power of the velocity. Nevertheless it is a remarkable fact that such a velocity as one mile per second has been reached.

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Summary.

To summarize what I have spoken about at some length, the factors which bring about such long ranges are—

High ballistic efficiency of projectile.

High velocity.

Velocity alone is useless without high ballistic efficiency of projectile, and the greater the calibre of gun we employ, the greater will this efficiency be. Given both requisites, the rapidly diminishing air density with altitude does the rest.

The employment of a long and heavy gun is inevitable.

As regards the pressure to which these guns should be worked, the higher the pressure the shorter the gun within limits. But to use much higher pressures than those at present, is not very feasible or desirable.

CONCLUSION.

In conclusion, I want particularly to emphasize the fact that there is nothing abnormal about this gun the Hun is using, because all the points I have drawn your attention to in connection with it, are points that have been known to us for many years. "Punch" has said "The gunnery experts of the Allies say that we could have built guns of this nature, if only we had thought of it. Well we did not think of it, but we must now take the Long Range Gun seriously. It has come to take its place amongst all the other weapons that are being used in the Great War. I do not say for a moment that the employment of such a gun would win the war,—far from it—but it fulfils a mission as does each engine of war devised. And these have been manifold in the last four years.

It will probably have a rapid development in the future—say in the next 20 years: Peace or War, it must be considered.

From such data as I have given you, it is patent that for still bigger guns and higher velocities, the engineering difficulties of construction will go up by leaps and bounds,—and we shall have in all probability, to acclimatise ourselves to a radical change in the scale of gun building. As regards the question,—'What useful purpose will such a gun serve'? My reply is—Quite apart from any policy that may dictate its employment as a weapon of war, we should be able to add quite a lot of valuable information to our scientific knowledge of artillery by building a gun of this nature and carefully experimenting with it. Progress demands that we must always be marching towards a further goal or higher limit, and in this respect artillery is no exception. (Loud and continued applause).

THE CHAIRMAN: Has any gentleman any question to ask the Lecturer ?

GENL. CLEEVE: Are there any data which have been found out from the French as to the fall of the projectiles in Paris?

MAJOR MAITLAND-ADDISON: Yes Sir, but they are confidential. I can hardly say anything as regards the accuracy except this, that I see no reason to suspect that it need be anything less than normal.

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The trajectory lies three-fourths 'in vacuo' and can only be affected by the atmosphere on the two stilts, namely the upward stilt and the downward stilt, and so proportionately a gun which will fire 75 to 100 miles will in all probability be more accurate than are the smaller guns we have been using. I do not see any reason why the whole 100 per cent. of rounds should not be placed in a distance of well under a mile at 100 miles.

GENL. CLEEVE: That is what I wanted to find out.

MAJOR MAITLAND-ADDISON: Yes Sir; that is purely a conception of course; it is difficult to say what the accuracy is without knowing more.

BRIG.-GENL. PERCEVAL: Would there be any difficulty about a traverse in the mounting do you think?

MAJOR MAITLAND-ADDISON: I cannot myself see Sir, why there should be any very great difficulty. The gun is nothing more than the normal weight for a big gun, possibly some 70 or 80 tons, but apparently all the 'experts', that exist at the present moment, say it is probable that this German gun is directed on fixed lines. I think we ourselves would probably design a mounting to permit a traverse.

COL. BETHELL: About the weight of the gun, we are told the weight of the gun would be about 80 to 90 tons relying only upon the necessary strength to prevent it from bursting. Now it seems rather doubtful whether a gun of that length would not be so whippy as to require a very considerable increase of weight to make it rigid; that is to say the gun would have to be built primarily as a rigid girder and then, so to speak, have a hole made in it to make it into a gun. It would probably take the shape of a hollow tube built as a girder and enclosing the gun. Now if that were the case the 80 or 90 ton estimate of weight would be far below the reality, and I should like to know whether that point has been considered.

MAJOR MAITLAND-ADDISON: I have considered that point Sir. I really do not see that there is going to be any great "whip" in such a gun. A small amount of droop or whip is almost immaterial in such a problem as this long range firing. Guns are very much more rigid than people would imagine them to be. If we take the normal 12-in. gun of 50 calibres in length there is not more than some seven or eight minutes of droop. There is a certain amount of whip it is true, but I do not think those two factors would enter vary largely into this gun. Of course, it would be possible to give it girder strength if necessary without vastly increasing its weight. The jacket, for example, of the gun might be made oval in shape with the thick part of the oval towards the top and the bottom, or it might be strutted to give it girder strength in the ordinary way that is done in bridge construction. But again I see no great necessity for that. The gun I designed to show to you on the screen has a factor of safety of over 1½ and that is the usual factor of safety which we use in gun construction. Such a gun should be rigid enough.

AN OFFICER: Can you tell us how the shock of the recoil is taken up?

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MAJOR MAITLAND-ADDISON: The shock of recoil could be taken up in the normal way. The recoil in this case would not be excessive because the weight of the projectile is only 330 lbs. for a gun of enormous weight that is to say a gun from 80 to 90 tons in weight. Therefore nothing more than the ordinary recoil arrangements are required to absorb the recoil energy.

A LADY: I would like to hear if the gun makes any sound at all; does anybody know yet?

MAJOR MAITLAND-ADDISON: I think, personally speaking, the gun must make a great noise, on account of the high muzzle pressure which can be very little less than 8 lbs. to 10 tons to the inch, and it is the pressure of the gases at the muzzle of the gun which causes noise. If we had a gun of infinite length so that the gases expanded down to normal atmospheric pressure in the bore there would be practically no noise. In this case the gas is at liberty to expand into the atmosphere at a pressure of nearly 10 tons so that the noise should be very high and there is probably a good deal of smoke too. I understand the Germans release large clouds of smoke to conceal the gun in its emplacement.

THE CHAIRMAN: Now Ladies and Gentlemen, if there are no other questions to ask it only remains for me to thank Major Maitland-Addison very warmly indeed for his most interesting lecture on behalf of everybody here present. (Loud and continued applause).

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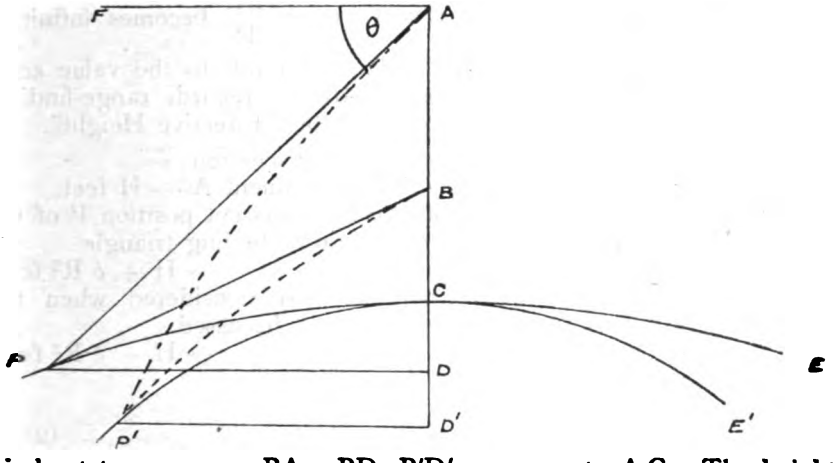
NOTES ON THE ERRORS OF VERTICAL BASE RANGE-FINDERS.

By Lieut. A. Hutchison, Clyde R.G.A. (T).

I. Curvature and Refraction.

In the diagram P′ C E′ represents the surface of the sea, P′ an object on its surface, PCE the spherical surface upon which objects appear to lie by refraction, and A a vertical base range-finder. By refraction the tangent at P′ to surface P′CE′ is bent to appear as tangent to PCE at P, the apparent position of the object P′, and P′A



is bent to appear as PA. PD, P′D′ are perp. to A.C. The height AC is increased by curvature and refraction to AD. Normally PCE is taken as a spherical surface whose curvature is 1/7 less than that of P′CE′. The apparent angle of depression θ to the object is considered so small that we regard PA, PD, P′A, P′D as of equal length, say R yds. From G.A.T. Vol. I we have

$$CD = \cdot1845 \times 10^{-6} R^2 \text{ feet}$$
$$= b R^2 \text{ feet where range to object is R yds.}$$
$$\text{and } b = \cdot1845 \times 10^{-6}$$

APD is the range-finding triangle.

II. Effective Height.

If θ minutes is the angle of depression to P, then by the 1146 Rule,

$$\theta = \frac{(H + b R^2)\, a}{R}$$

where $a = 1146$
$b = \cdot1845 \times 10^{-6}$
H = ht. AC in feet.
R = range to object in yards.

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Considering a small error dR in R due to a small error $d\theta$ in θ, we have

$$d\theta = a\left(-\frac{H}{R^2}+b\right)dR = -a\left(\frac{H}{R}-bR\right)\frac{dR}{R}$$

the negative sign showing that an increase of θ leads to a decrease of R, and vice-versa.

$$\text{Neglecting sign, } \frac{dR}{R} = \frac{R\,d\theta}{a(H-bR^2)} = \frac{R\,d\theta}{ah} \quad \ldots\ldots\ldots\ldots (1)$$

where $h = H - bR^2$. The height h is known as the "Effective Height".

In the diagram BC may be considered equal to CD, therefore $AB = H - bR^2 = h$. The relative error $\frac{dR}{R}$ becomes infinitely great i.e. range-finding is impossible as h tends to the value zero. The height BC is therefore non-effective as regards range-finding, and hence the reason why AB is called the "Effective Height".

There are really three heights under discussion:—

(1) AC, called the height of the instrument A — H feet.

(2) AD, the height of A above the apparent position P of the object, and the base of the range-finding triangle — $H + bR^2$ feet.

(3) AB, the "Effective height", only considered when the accuracy of the range finding is discussed — $H - bR^2$ feet.

Equation (1) may be written

$$dR = \frac{R^2\,d\theta}{a\,h} \quad \ldots\ldots\ldots\ldots\ldots (2)$$

Note 1.

which shows that the error dR is not strictly proportional to the square of the range, as h is a function of R. It is easy to show that for the same angular error $d\theta$, the error dR is more than quadrupled at double the range, a fact which can be verified by reference to the 15″ error table in Part I, Manual of C.D. Range-finding.

III. Height necessary for Accurate Range-finding.

By "accurate", we mean conventionally that the greatest value allowed to $\frac{dR}{R}$ is $\frac{1}{100}$ i.e. the error does not exceed 1% of the Range.

By equation (1) $\frac{dR}{R} = \frac{R\,d\theta}{ah}$

$$\therefore h = \frac{R\,d\theta}{a} \Big/ \frac{dR}{R}$$

h will be least when $\frac{dR}{R}$ is greatest for any assigned values of R and $d\theta$.

$\therefore h = \frac{100\,R\,d\theta}{a}$ gives the effective height necessary,

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dependent upon the value we assign to $d\theta$. From experience we say that the error $d\theta$ in alignment should not exceed about $\frac{1}{4}'$ or $15''$, and it is probably better to take $1/5'$ for a P.F., and $\frac{1}{3}'$ for a D.R.F. which is not so well constructed as a P.F.

Taking these values, we get

$$h = \frac{R}{57{\cdot}3} \quad \text{for a P.F. .....(3)}$$

$$\text{and } h = \frac{R}{34{\cdot}4} \quad \text{for a D.R.F. .....(4)}$$

These equations are of course not exact.

Since $H > h$, we write very approximately

$$H = \frac{R}{50} \quad \text{for a P.F. .....(5)}$$

$$\text{and } H = \frac{R}{30} \quad \text{for a D.R.F. .....(6)}$$

Equations (5) and (6) mean that with a P.F. we require 100 feet for every 5000 yds., and with a D.R.F. 100 feet for every 3000 yds. to get "accurate" ranges. These statements agree approximately with the figures given in official publications.

IV. Percentage Accuracy Expected.

By equation (1) $\frac{dR}{R} = \frac{Rd\theta}{ah}$

$$\therefore \frac{dR}{R} \times 100 = \frac{100\,Rd\theta}{ah}$$

Putting $d\theta = 1/5$ for a P.F., and $\frac{1}{3}$ for a D.R.F. we get

$$\frac{dR}{R} \times 100 = \frac{R}{57{\cdot}3\,h} \quad \text{for a P.F. .....(7)}$$

$$\text{and } \frac{dR}{R} \times 100 = \frac{R}{34{\cdot}4h} \quad \text{for a D.R.F. .....(8)}$$

As rough practical rules, easy to remember we write:—

$$\frac{dR}{R} \times 100 = \frac{R}{50\,H} \quad \text{for a P.F. .....(9)}$$

$$\text{and } \frac{dR}{R} \times 100 = \frac{R}{30\,H} \quad \text{for a D.R.F. .....(10)}$$

Thus with a P.F. height 300 feet, at a range 15000 yds., we expect $\frac{15000}{50 \times 300}$ % error i.e. 1% error i.e. 150 yds.

V. Error in Range due to error in the length of the base.

So far, angular errors alone have been considered. Errors in the length of the base result from two causes

(a). Not redatuming—an avoidable error.

(b). Abnormal refraction—unavoidable as the instrument is constructed to correct for normal refraction.

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Taking as above, $\theta = \frac{(H + b R^2) a}{R}$, consider an error dR in R due to an error dH in H.

Now θ is a function of two variables H and R.

Let $\theta = f(H, R)$

$$\therefore d\theta = \frac{df}{dH} dH + \frac{df}{dR} dR$$

$$\because d\theta = a \left\{ \frac{1}{R} dH + \left(b - \frac{H}{R^2} \right) dR \right\}$$

θ is supposed constant here, $\therefore d\theta = O$

$$\therefore \frac{dH}{R} = \left(\frac{H}{R^2} - b \right) dR$$

$$\therefore dH = (H - b R^2) \frac{dR}{R}$$

$$\therefore \frac{dH}{h} = \frac{dR}{R} \qquad \text{.....(11)}$$

The relative error $\frac{dR}{R}$ due an error dH is inversely proportional to the "Effective height".

Approximately we write:—

$$\frac{dR}{R} = \frac{dH}{H}$$

Thus percentage error in Range is equal to the percentage error in height (approx.).

VI. Effect of Abnormal Refraction.

Suppose that refraction is greater than the normal i.e. the range finding formula is

$$\theta = \left(\frac{H + b^1 R^2}{R} \right) a \quad \text{where } b^1 < b, \text{ the normal value.}$$

Suppose also that the instrument is datumed at r yards.

$\therefore$ height of instrument above apparent position of D.P.

$= H + b^1 r^2$. Now of this height, the red graduated portion of the ht. drum shows br^2 which is the normal value of the C. and R. correction at r yds In this case the drum over corrects for C. and R. Therefore the black-graduated portion records as the height

$H + b^1 r^2 - br^2$ or $H - (b - b^1) r^2$ *instead of H.*

Now align the instrument on an object distant R yds, R being greater than r say.

If θ is the angle of depression to apparent position P,

then $\theta = \left(\frac{H + b^1 R^2}{R} \right) a$

Let R_1 be the range recorded on the bar.

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$$\therefore \quad \theta = \left(\frac{H - (b - b^1)\,r^2 + b\,R_1^2}{R_1}\right) a$$

$\therefore$ R and R_1 are connected by relation

$$\frac{H + b^1 R^2}{R} = \frac{H - (b - b^1)\,r^2 + b\,R_1^2}{R_1}$$

Simplifying we get

$$H(R_1 - R) + b^1R^2R_1 + (b - b^1)r^2R - bRR_1^2 = O$$

Since $r < R$

$$\therefore \quad H(R_1 - R) + b^1R^2R_1 + (b - b^1)R^3 - bRR_1^2 > O$$

Note 2.

$$\therefore \quad (R_1 - R)[H + b^1R^2 - b\,RR_1 - bR^2] > O \quad \ldots\ldots\ldots\ldots(12)$$

As b^1R^2, bRR_1, and bR^2 are small compared with H, the second factor of expression is positive.

$\therefore$ $R_1 - R$ is positive.

$\therefore$ $R_1 > R$

i.e. the recorded range is too great Similarly we may show that ranges less than the D.P. range are recorded too small. The converse of these statements hold good when refraction is less than normal.

NOTES BY A CRITIC.

Note 1. Part ii Coast Defence R.F. proves this.

Note 2. $\dfrac{H + \mu R^2}{R} = \dfrac{H - (\lambda - \mu)r^2 + \lambda R_1^2}{R_1}$ Putting $\left.\begin{matrix} b = \lambda \\ b^1 = \mu \end{matrix}\right\}$ for convenience.

This is a quadratic equation in R_1 and therefore it is necessary to consider the correct root.

Your equation (12) and the following reasoning does not do this. I suggest this:—

Let $R_1 - R = x$

Then $(H + \mu R^2)(R + x) = R[H - \lambda - \mu r^2 + \lambda (R + x)^2]$

$$\therefore \quad \lambda R x^2 - x[H - R^2(2\lambda - u)] + (\lambda - \mu)\,R\,(R^2 - r) = O$$

Let x_1 and x_2 be the roots of this equation. The values of x_1 and x_2 correspond to the two pairs of points in which the line of sight cuts the loci of the apparent positions of the object—which curves are really parabolas. [For normal refraction the radius of curvature of the parabola at C is $\dfrac{7\rho}{6}$ where ρ = radius of earth].

Thus we are plainly concerned with the smaller root only, x_2 say.

We have $x_1 + x_2 = \dfrac{H - (2\lambda - \mu)R^2}{\lambda R}$ $\quad x_1 x_2 = \dfrac{(\lambda - \mu)(R^2 - r^2)R}{\lambda R}$

In general (i.e. except for very small values of H, giving very little accuracy of ranging) $\dfrac{H - 2\lambda - \mu R^2}{\lambda R}$ is positive.

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This $x_1 + x_2$ is positive.

Case 1. $\lambda > \mu$ & $R > r$ $x_1 x_2$ is + ve $\therefore x_2$ is + ve $\therefore R_1 > R$.

" 2. $\lambda > \mu$, $R < y$ $x_1 x_2$ is − ve $\therefore x_2$ is − ve $R_1 < R$.

" 3. $\lambda < \mu$, $R > v$ $x_1 x_2$ is − ve $\therefore x_2$ is − ve $\therefore R_1 < R$.

" 4. $\lambda < \mu$, $R < v$ $x_1 x_2$ is + ve $\therefore x_2$ is + ve $\therefore R_1 > R$.

APPENDIX.

I am indebted for the above valued criticism, as the result of which the following additional points should be noted.

(1). The side AP of the triangle APD cuts the locus PCE in 2 points, thus corresponding to any one value of θ, there are 2 values of R.

(2). The range finding equation $a\,b\,R^2 - \theta\,R + aH = O$ may be regarded as the polar equation of cocus PCE. Changing to Cartesians and assuming that $\cos\theta = 1$, and $\sin\theta = \theta$ since θ is small, we get $a\,b\,(x^2 + y^2) - Ry + a\,H = O$, the equation of a circle. Neglecting y^2, as y is small, we get $ab\,x^2 - Ry + aH = O$, the equation of a parabola. The locus PCE may then be regarded as a parabola approximately.

(3). The quadratic equation $a\,b\,R^2 - \theta\,R + aH = O$ has in all practical cases one of its roots very large compared with the other root, as the coefficient of R^2 is very small compared with that of R. It is the smaller value that concerns us.

(4). The equation of P^1CE^1, referred to rectangular axis through C is strictly $\rho^2 = x^2 + (\rho - y)^2$ where $CD^1 = y$, $P^1D^1 = x$, ρ = radius of earth. Approximately this is $x^2 = 2\rho y$, neglecting y^2. This is the equation of a parabola.

(5). Taking $CD = \frac{6}{7}\,CD^1$, as usual, equation of PCE becomes $y = \frac{3}{7}\,\frac{x^2}{\rho}$. This gives $\frac{7}{6}\,\rho$ as the radius of curvature at the vertex C of the parabola PCE.

(6). The equations from which equation (12) is deduced have each 2 values of R and R_1 respectively, corresponding to the same value of θ. In both discussions, the smaller value of R is taken, as the one appertaining to practice. For a similar reason the discussion by the inequality has reference to the smaller value of R_1 which alone has a practical bearing, this value being comparable with that of R chosen. It seems hardly necessary to discuss the second value of R_1 which is so great by comparison, that of course in all cases it is greater than R. With this proviso, the discussion is valid. An examination of the relative magnitudes of the coefficients in the quadratic discussed by "Critic" reveals the same facts.—A.H.

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Contents of R.A. Journal, August, 1918.

The Distribution of the Energy contained in a Cordite Charge for ·303-in. Mk. VII Cartridge. By Major J. H. Hardcastle, *pac.* (late) R.A., R. of O. 157
Displacement Corrections. By Lieut. P. W. F. Brown, R.G.A. 164
Driving Band Gauges. By Lieut. P. W. F. Brown, R.G.A..... 164
Liaison. By A. G. C. 165
The Simplest and most Accurate Form of Grid. By Major E. H. Lovell, R.G.A. 169
Sport in Mesopotamia. By Brig.-Genl. H. J. A. Mackey, C.M.G., M.V.O., D.S.O. 173
Short Chronology of events connected with the *matériel* of Artillery, down to the year 1886. By Lieut.-Col. H. W. L. Hime. 175
Ranging on the Line of Observation. By Temp. 2nd Lieut. J. P. Campbell, R.F.A. 178
Distribution or Concentration Rule. By Temp. 2nd Lieut. J. P. Campbell, R.F.A. 180
The Gunner's Rule. By "Newly Fledged". 182
The Gunner's Rule. By Sagittarius Secundus. 185
Ready Reckoner for Wind Corrections. By 2nd Lieut. F. G. Witts, R.G.A. 186
Built-in Beams in Dug Outs. By Temp. Lieut. E. S. Stanley, R.G.A. 188

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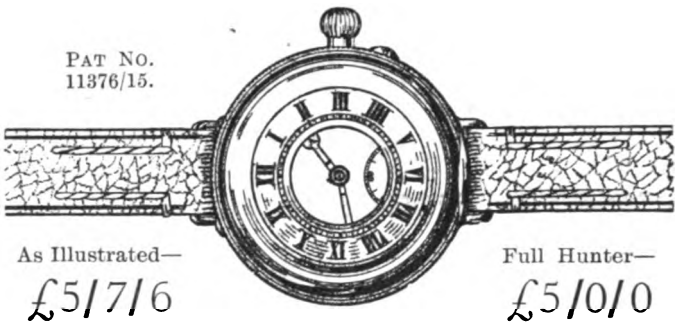

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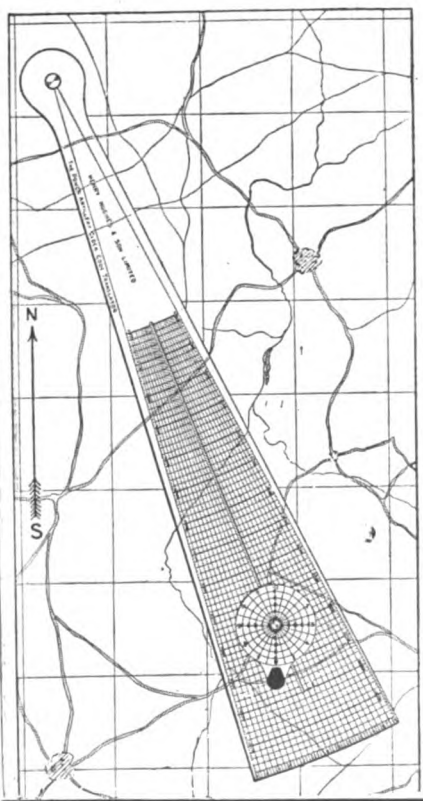

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THE DISTRIBUTION OF THE ENERGY CONTAINED IN A CORDITE CHARGE FOR ·303-in. Mk. VII CARTRIDGE.

BY MAJOR J. H. HARDCASTLE, *pac.* (LATE) R.A., R. of O.

EACH grain of M.D. Cordite contains just under 200 ft. lbs. of Energy. The Mark VII. bullet carries away with it very little more than 60 ft. lbs. of this energy. The problem is to account for the remaining 70% of the energy.

Previous literature on the subject.

In 1903, Mr. R. H. Housman of Kynoch Ltd., published in "Technics" the first known attempt at a solution. His figures were for size 3¾ Cordite Mark I. :—

	Ft. lbs. per grain.	Percentages.
Carried away by bullet as kinetic energy ...	66	28·1
Carried away by bullet as heat	11	4·7
Imparted to barrel by friction	11	4·7
Imparted to barrel by hot gases	59	25·1
Carried away by gases	88	37·4
Total ft. lbs. per grain	235	100·0

Beyond the fact that he obtained the figure 235 ft/lbs. per grain from Sir Andrew Noble's published works and that he used a ·303 proof barrel with eleven radial pressure gauges at intervals all along the bore (which barrel is at present in my care) it is not known how he arrived at the distribution.

Sir Andrew Noble in Phil: Trans: A 410, 1906, "Researches on Explosives" Part IV., gave among other things the following particulars for six different powders, including Mk. I. and M.D. Cordite at a variety of densities of loading :—

(a) Pressure in atmospheres.

(b) Volume of total gases formed per gramme of explosive reckoning the water formed in its gaseous condition.

(c) Temperature of explosion, centigrade.

(d) Units of heat (calories) formed per gramme, water gaseous.

As pointed out by several people soon after publication neither of Noble's methods of calculating temperatures of explosion is satisfactory to a chemist. The figures published by Monsieur L.

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Morellet in "Kynoch Journal" Vol. VI., Oct. 1905, p. 192, using Clausius' formula have therefore been substituted. A line has also been added giving the value of the constant to be used in the pressure-density formula of expansion

$$\text{P tons per square inch} = \frac{\text{a constant}}{\frac{1}{\Delta} - \frac{1}{1{\cdot}58}}$$

where 1·58 is the specific gravity of colloid powders, and Δ is the density of the gas compared to water. As the total gases formed, the calories and the temperature vary slowly with the pressure, an average value of about 17 tons per square inch has been assured for the following table:—

	Italian Ballistite.	Mk. 1. Cordite.	M.D. Cordite.	Norway Ballistite. 167.	Norway Ballistite. 165.	Nitro-cellulose. Rothwiel.
Volume of total gas	810	870	900	890	900	920
Temperature. Cent.	3100	3100	2700	2600	2500	2300
Energy ft./lbs. per grain	245	235	195	190	180	175
Pressure constant ...	68	75	70	66	64	61

As 1 calorie = 3·085 ft/lbs., and 1 gramme = 15·43 grains the energy per grain is practically exactly $\frac{1}{5}$ of the calories per gramme.

Clausius' formula is:—

$$t^{\circ}\text{ Cent.} = \left\{273 \frac{P_{\Delta}}{P_0}\left(\frac{1 - \frac{v\,\Delta}{1000}}{v\,\Delta}\right)\right\} - 273^{\circ}$$

Where $P\Delta$ is the pressure in atmospheres at density Δ

P_0 is atmospheric pressure = 1·0

v is volume of total gases per gramme

-273° is the temperature of absolute zero or inter-stellar space.

In 1908, the German ballistician, Dr. Cranz, writing with Dr. Rothe, published an elaborate analysis of the subject in "Zeitschrift fur das Cesamte Schiess und Sprengstoffwesen."

An English abstract of it appeared in "Arms and Explosives," September, 1917. The table for the German rifle may be abstracted as follows:—

Muzzle energy of bullet	32·8%
Rotation energy of bullet	0·1%
Transferred to barrel as heat etc.	22·5%
Ejected at muzzle in gases	44·6%
Total ...	100·0%

Cranz and Rothe's article is chiefly interesting for its fine display of instrumental appliances and a certain curious absence of evidence of practical acquaintance with the handling of firearms.

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More recent Experiments in England.

Experiments have often been made with a Maxim gun to find out how many rounds it takes to bring the water to a boil. The Fahrenheit temperature of the chamber is taken by a thermometer before beginning and after each belt.

Temperature.	Before.	After 1st belt.	After 2nd belt.	When boiling.	Rounds.
Run of Work Cordite VII. ...	66	121	169	195	653
U.M.C. Dupont No. 19 VII. ...	71	110	163	197	716
U. S. Dupont No. 16 VII.... ...	72	123	168	193	704
Winchester Dupont No. 16 VII....	78	113	150	172	650
M.D. Strip. New Barrel. VI. ...	46	107	154	190	708
Axite New Barrel VI.	44	111	162	191	726
M.D. Strip. Worn Barrel. VI. ...	48	119	165	196	631
Axite Worn Barrel. VI.	48	101	171	192	664

Experimental results for other guns are as follows:—

Gun.	Bullet grains.	Calibre.	M.V.	Rounds to boil water.	Pints, capacity of jacket.
German Maxim	154	·311	2850	560	5·8
Russian Maxim	150	·300	2850	580	6·3

The capacity of the ·303 Maxim water jacket is just under 7 pints or 8·8 lbs. of water. The weight of the brass and iron in the barrel and jacket, which are also raised to boiling point, are about 20 lbs. Both of these metals require only about 1/10th of the heat energy required by water to rise an equal amount in temperature and therefore this 20 lbs. counts as 2 lbs. of water, making (say) 11 lbs. of water altogether to be raised to the boil. The mechanical equivalent of heat is 777 ft. lbs. to raise 1 lb of water 1° Fahr. As a good deal of heat is lost by radiation during the firing of 3 belts it is fair to count 600 rounds as required to raise 11 lbs. of water 150° Fahr. from 60° Fahr. to 212° Fahr. Each round therefore puts 2140 ft. lbs. of energy into the water jacket. Counting 37½ grains of Cordite to the round this gives 57·1 ft. lbs. per grain.

The total energy per grain of M.D. Cordite is 195 ft. lbs. per grain, according to Noble, or 7320 ft. lbs. per round of Mark VII.

The bullet weighs 174 grains and has a muzzle velocity of 2440 f/s or 2300 ft. lbs. of energy. There are therefore 7320 − 2140 − 2300 = 2880 ft. lbs. still unaccounted for.

The momentum of recoil of the Mark VII cartridge is about 80 seconds lbs. and the rifle weighs about 9 lbs. The velocity of recoil is then about 9 f/s., and the energy of recoil is about 11 ft. lbs.

The energy of the gas as the bullet leaves the muzzle is taken as that due to half the weight of cordite and the whole of the muzzle velocity, say 254 ft. lbs.

These two items together account for 265 ft. lbs. leaving 2615 ft. lbs. to be accounted for.

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It is known that a Mark VII bullet which has a cracked envelope or a hole bored purposely through the envelope sometimes sprays out a fine stream of molten lead as it flies through the air for some yards. The melting point of lead is 325° C. or 617° Fahr., so that the rise of temperature required is at least 550° Fahr. The weight of the Cupro-nickel envelope is 40 grains, equal to 4 grains heat value of water. It seems impossible that the bullet can absorb in friction less than the amount of heat required to raise the jacket to the melting point of lead, say 260 ft. lbs. The heat in the ejected fired case and the energy of rotation of the bullet accounts for another 40 ft. lbs., making 300 ft. lbs. altogether. This leaves 2315 ft. lbs. which is ejected unused from the muzzle.

Accordingly the table for Mark VII. Cordite, assuming the energy imparted to the barrel by friction = energy imparted to the bullet by friction = 260 ft. lbs., leaving 2140 - 260 = 1880 ft. lbs. received by the barrel from the hot gases, seems to run:—

	ft. lbs.	ft. lbs. per grain.	Percentage.
Carried away by bullet as muzzle energy ...	2300	61·4	31·4
Carried away as gas energy to muzzle ...	254	6·8	3·5
Carried away as heat	260	6·9	3·5
Carried away as energy of rotation	35	0·9	0·5
Imparted to barrel by friction 260 ... / Imparted to barrel by hot gas 1880 ...	2140	57·1	29·2
Recoil	11	0·3	0·1
Heating Cartridge Case	5	0·1	0·1
Ejected at muzzle	2315	61·7	31·7
Total ...	7320	195·2	100·0

Comparing the percentages with the other two tables of Housman and Cranz we have:—

	This table.	Housman.	Cranz.	Average.
Muzzle energy	31·4	28·1	32·8	31
Bullet heat	3·5	4·7	say 4·0	4
Gas energy	3·5	—	—	1
Rotation	0·5	0	0·1	—
Recoil	0·2	—	—	—
Barrel friction ... ... / Barrel heat by gas	3·5 / 25·7	4·7 / 25·1	22·5	27
Ejected	31·7	37·4	40·6	37
Total ...	100·0	100·0	100·0	100

Cranz relied on an electrical and artificial method of measuring the heat absorbed by the barrel. The use of a Maxim gun does not appear to have occurred to him, hence his discrepancy. Housman was almost certain to have used the direct method as he was familiar with machine guns.

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The use of the figures in the table.

It is very desirable to know the distribution of the pressure along the bore as well as the position of maximum pressure and its true value in tons per square inch. The experimental and mathematic difficulties are however considerable and the help of all subsidiary figures is welcomed. The total energy enclosed by the pressure space curve or indicator diagram of the rifle would be a valuable assistance. The figures in the table give some clue to this. Accordingly the items of the table have been tentatively distributed among the various indicator diagrams which are capable of being worked out.

(a) The diagram of effective pressure.

(b) The diagram which would be given by a set of perfect crusher gauges along the barrel.

(c) The diagram which a perfect calculation based on the pressures observed in a closed vessel after allowing for the usual cooling effect of the walls of the closed vessel might give.

The cooling of the gas due to the barrel is roughly estimated at 25% of 3120 = 780 ft. lbs.

(d) The diagram as for (c) based on results in a closed vessel entirely impervious to heat, such as a perfect Maxim jacket.

	Ft. lbs. total.	a, effective.	b, crusher.	c, uncooled.	d, maxim.
Energy of Bullet... ...	2300	2300	2300	2300	2300
Energy of Gas	254	—	254	254	254
Bullet heat	260	—	260	260	260
Bullet rotation	35	—	35	35	35
Recoil	11	—	11	11	11
Barrel friction	260	—	260	270	260
Barrel by Gas	1880	—	260	(say) 780	1880
Cartridge Case	5	—	—	—	—
Ejected at Muzzle ...	2315	—	—	—	—
Total ...	7320	2300	3120	3900	5000
Percentage of Total ...	100·0	31·4	42·6	53·3	68·3
,, of effective ...	318·0	100·0	135·6	169·5	21·74
,, of uncooled...	—	59·0	80·0	100·0	128·2

The diagram based on (c) the uncooled pressure curve, is the only experimental basis at present available from which a mathematical calculation of ballistics can start, using closed vessel pressures as its foundation. Accordingly the pressure space curve bounded by the maximum pressure and continued to the muzzle by the curve

$$P = \frac{\text{constant}}{\frac{1}{\Delta} - \frac{1}{1{\cdot}58}}$$

must contain a greater area than 3900 ft. lbs.

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The curve bounded by the results given by a gun like Housman's multiple gauge gun must not contain more than 3120 ft. lbs., and must contain much more than 2300 ft. lbs.

The velocity curve of a rifle can be obtained with considerable accuracy by cutting off an inch at a time from the barrel and taking velocity at each length. This has been done and it is found that 10% shortening of the barrel reduces the velocity by more than 1·6%.

If the effective length of the barrel or the shot travel is designated by "u" then

$$\log V = \text{a constant} + (0{\cdot}14 \log u)$$

From this equation and the known muzzle energy of the bullet an effective pressure space can be built up from the muzzle to half travel. The efficient muzzle pressure is given by

$$\left.\begin{matrix}\text{E.M. Pressure} \\ \text{tons per sq. inch}\end{matrix}\right\} = \frac{\text{volume of shot travel bore (cub. inch).}}{0{\cdot}14 \times \text{Muzzle energy foot tons} \times 24}$$

The result is nearly exactly 2 tons per square inch at the actual muzzle rising to about 3 tons at half travel.

The uncooled muzzle pressure is about 5 tons per square inch and the Housman Gun gives about 3 tons.

The attached diagram shows these results approximately. The rectangular area below the zero line being the energy found in the water jacket but not appearing ever as pressure, viz:

$$1880 - 780 = 1100 \text{ ft. lbs.}$$

The rectangular area outside the muzzle is

$$7320 - 5000 = 2320 \text{ ft. lbs.}$$

The pressure scale of tons per square inch is also scaled as lbs. dead weight at the rate of $P \times 0{\cdot}0755 \times 2240 = 170$ lbs. to 1 ton as the area ofthe bore is 0·0755 square inch.

As a matter of general interest the diagram has been completed so as to show the continuous velocity time and energy curves, derived from the effective pressure curve, from shot start to muzzle.

The appendix gives in tabular form the figures required for plotting the curves.

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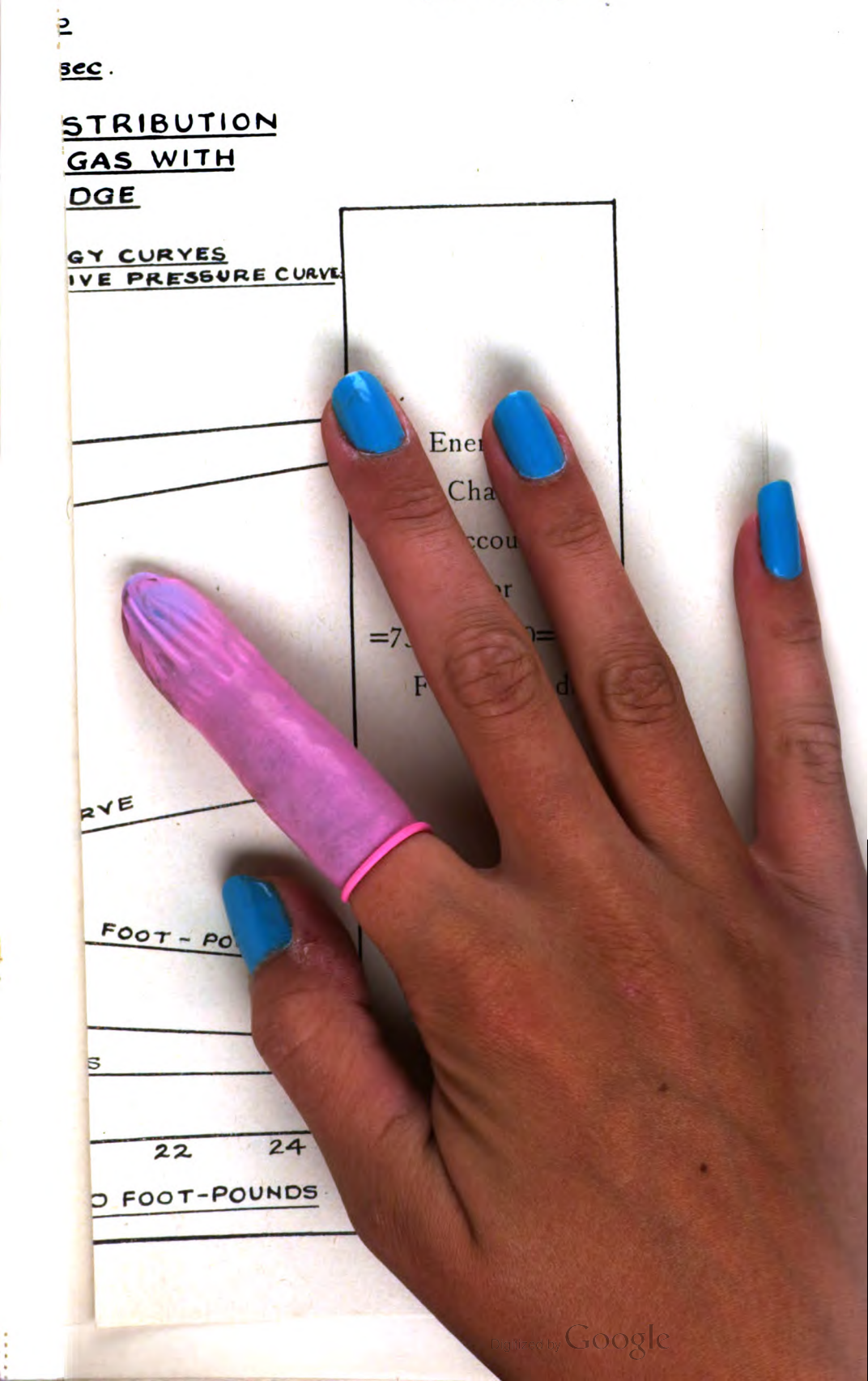
[To face page 162.



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APPENDIX.

Pressures, Velocities etc., up Barrel (·303″).

u. (ins.)	Shot travel (ins.)	Effective Pressure. (tons/in²)	Velocity (f/s.)	Time (in 1/10,000 secs.)	(adjusted) Energy lbs. f/s.	Acceleration f/s./sec.
1·8	0	13·6	0	0	0	2,978,000
2·0	0·2	15·0	310	1·1	40	
2·2	0·4	15·6	460	1·5	80	
2·6	0·8	16·4	665	2·1	170	
3·0	1·2	16·8	825	2·5	260	
		Max.				
3·5	1·7	17·0	985	3·0	380	3,722,000
4·0	2·2	16·8	1140	3·4	495	
5·0	3·2	15·8	1370	4·0	720	
6·0	4·2	14·6	1560	4·6	930	
7·0	5·2	13·0	1710	5·1	1120	
8·0	6·2	11·4	1830	5·6	1290	
9·0	7·2	9·8	1940	6·0	1440	
10·0	8·2	8·4	2020	6·5	1460	
11·0	9·2	7·2	2080	6·9	1670	
12·0	10·2	6·0	2140	7·3	1765	
13·0	11·2	5·2	2190	7·6	1840	
14·0	12·2	4·4	2240	8·0	1925	
16·0	14·2	3.2	2290	8·8	2015	
18·0	16·2	2·6	2330	9·5	2080	
20·0	18·2	2.5	2370	10·2	2150	
22·0	20·2	2·4	2400	10·9	2210	
24·0	22·2	2·2	2430	11·6	2265	
25·3	23·5	2·0	2450	12·0	2300	438,000
Muzzle.						

Calculated from Velocity Curve.

Note 1. First column shows distances (ins.) from base of case.

Note 2. To get acceleration from Effective Pressure (P tons/sq. in.)

$$\text{Acceleration } P \times = \frac{2240 \times g \times \text{mean bore (sq. in.)}}{\text{bullet weight (lbs.)}} =$$

$$\frac{P \times 2240 \times g \times \cdot0755 \times 7000}{174} = P \times 219{,}000$$

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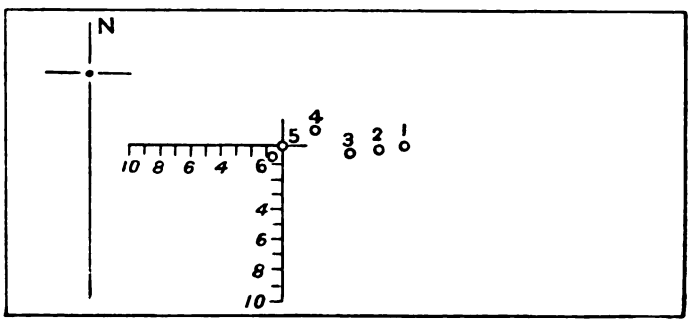
DISPLACEMENT CORRECTIONS.

By Lieut. P. W. F. Brown, R.G.A.

WITH reference to the article on Displacement Corrections in the January number of the "Journal" a co-ordinate measure added to the cross on the pivot gun position as indicated in the Diagram has been tried and found most useful.



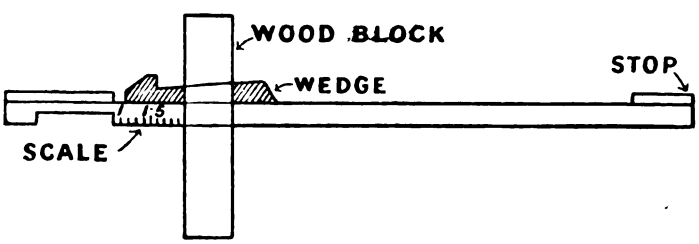
DRIVING BAND GAUGES.

By Lieut. P. W. F. Brown, R.G.A.

SINCE shells have now to be sorted according to the distance of the driving band from the base of the shell, the following adaption of the ordinary carpenter's gauge has been tried and found most successful.

The scale is measured from the point A and reads to 2″. The two stop blocks at the ends of the hand are to prevent the gauge block from coming off.

For sorting out groups of shells, the Gauge is set to the required reading and each shell tested, those nearest gauge being grouped together.



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LIAISON.

By A. G. C.

IF the general staff ever entertained any doubts about the relative mobility of 6″ howitzers and the field artillery pieces, these must have been set at rest by the extraordinary achievements of the former throughout the first week of the enemy offensive which started on March 21st. It is true that horse and field artillery batteries can occupy positions inaccessible to a mechanically drawn battery but it is rarely that the condition of the roads imposes any penalising limitations upon the choice of a position for medium howitzers, or jeopardises their effectiveness. In moving battles the 6″ how. can usually be fired from just off a road. If the weather be fine platforms are unnecessary in fact it is better to do without them if the ground be comparatively hard. Mats under the wheels are quite sufficient to ensure easy "switching" and absence of "jumpiness."

During the retreat we trekked and halted alternately for seven days: hated the trekking after the first day and loved the halting. Halting promised the better alternative, firing and resting. Once only during that seven days were we allowed to indulge in a really big strafe. For five hours we were left to our own devices with plenty of ammunition, no communications rearward, and an advancing enemy in front. We made full use of the glorious opportunity, the gunners have never worked better and the guns rarely behaved so well. This was the only bright spot in a gloomy week. Firing after this was just an interlude between wearying and exasperating spells of travelling—the wrong way.

Arnold Bennett's dictum was justified. Sleep is merely a matter of tradition and habit. Hitherto we've spent far too long in indulgence of a habit that in any excess produces sluggishness of liver, mental ineptitude, and premature corpulency. Use is second nature and we got well into our stride with the second, getting no sleep at all for six days.

Gunners are not easily discouraged, particularly those that spent last year in Flanders, wallowing in mud and had spent the blessful three months since on the beautiful wooded slopes of the extended line. The change from the desolation of desolations to a sojourn in a country resembling God's own—their own land—had a grand effect upon their morale. During the retreat the strain upon their physical resources was enormous but never once did a shell go home without that sweet familiar "plonk". However tired they were they would invariably help any emigré with a clumsy load, much to the amusement of the onlookers at times for a crazy wheelbarrow needs some skilful handling.

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Doubtless it was necessary but every retrograde step was a cruel disappointment. It was curiously interesting to note how the pugnasity of the race became more and more assertive, and found chagrined expression, during those days. "But honour came back as a King to Earth, and paid his subjects with a royal wage."

One glorious evening we heard a rumour that we should "advance" to help the French. By morning rumour had materialised into fact and just before noon we were in action at X . . . . Our men were manifestly delighted. It was a move forward and promised them some consistent firing.

We were put under the command of a French group commander, installed one of our own officers at his headquarters to act as our intermediary, and our senior battery commander—himself of French parentage—acted as liaison officer with the French division. No time was lost—lines were run out immediately to the O.P. a battery car being used as cable wagon. We registered both batteries during the afternoon. The O.P. itself was one of those we dream about but rarely find. The opposing forces of infantry were in a broad valley between two ranges of wooded hills. At one time during the war the Boche had occupied our slope of the hill and his usual accessories to safety were provided. We wondered what strategy it was that caused such a precipitate retreat of his forces, so hasty and unpremeditated that the usual marks of the Hun were conspicuously absent, villages and towns had been left untouched. On the opposite slopes a ruined chateau, cross-roads, lone trees, tiny copses and our lately abandoned hutments provided us with excellent ranging points. On the plain where it widened to the south were three stranded aeroplanes—two allied and one Boche—which had crashed or made forced landings during the retreat. These proved fatally interesting to the enemy infantry. It may have been curiosity or it may have been the desire to salve the machines which brought parties of the enemy to the planes. In any case we had a moving target and made the most of the opportunity—there were some new records for the quarter-mile put up that day. A calibration shoot on the ruined chateau was critically observed by the French N.C.O's on O.P. duty to whom we were indebted for the loan of an excellent observation instrument, not the only item of their equipment we coveted. Before dusk a machine gun post was discovered in the chateau walls and the French troops in the neighbourhood of the O.P. were roused to some display of enthusiasm by the accuracy and volume of our fire—ten round salvos make a fair splash and must have been as disconcerting to the enemy as it was interesting to our allies. This was an appropriate finale to the day's work.

Our French Commander who had waited to gush until he was assured of our effectiveness was highly delighted with our opening demonstration and our expedition.

On our part we regarded it in the light of a privilege to get properly into action again: our gunners felt rewarded for their extraordinary exertions and displayed the keenness arising out of a new satisfaction. Nothing is so encouraging to them as the evidence of their own officers as to the efficacy of their fire: one O.K. sent down from the O.P. by a battery officer means more to them than

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ten O.K'. given from an aeroplane—the former kind are rare enough to possess the charm of novelty and be the subject of elation: scepticism is born of lack of personal knowledge, faith with understanding.

That evening we sat down to dinner with appetites fitting our new won grace; we'd come into our own again and were duly thankful. Several calls for S.O.S. during the night added to our satisfaction; they spelt vigilance and resistance. Our two batteries, maintained a pleasant rivalry for the honour of getting off the first salvo in response to each call.

We were kept very busy the next day. The enemy in his enthusiasm, somewhat intoxicated by his successes dropped a good deal of his customary caution and rushed troops and material up in lorries over roads well under our observation. Innumerable living targets presented themselves to our view and an almost bewildering number of them were engaged by French 145's and 75's and by us.

Toward evening, having brought some of his own howitzers into position, the enemy attempted to neutralize a group of 75's and made himself generally unpleasant on our roads. One of his 15 cm. batteries was spotted immediately and a French battery brought to bear upon it, after we had convinced our fellow observers that our map was a representation of the same country as their own map purported to represent. They seemed rather dubious until the first neutralizing round fell well into the Boche when mutual confidence was at once restored.

Our O.P. was fairly obvious though security was afforded by the fact that its limits were not narrowly prescribed. The Boche, pursuing his well-defined policy of intimidation, immediately replied to our neutralization by shelling our vantage ground with another battery. He continued to display the same peevishness and antipathy to our peeping until we bade farewell to the place. The French observers regarded his shelling in the light of a compliment and were not in the least perturbed: a very substantial Boche reinforced concrete structure was partly responsible for our mental equilibrium.

The last day we were in action at X . . . . we fired practically continuously throughout the day until 11 p.m. and engaged a surprising number of targets. Refreshed by two nights sleep our men worked particularly well, the signallers splendidly. The latter had a very 'sticky' time on the last day the Boche having taken a violent dislike to the road.

It is interesting to record that no gun went out of action throughout the three days we were with the French. This was the more remarkable after seven days jolting over all sorts of roads and seven days firing from many more positions.

The last day at the O.P. was more than exciting but the most interesting of all. During this day the enemy made four distinct local infantry attacks, all of which were observed by us and all completely demoralised by the allied fire. The greatest enthusiasm prevailed in the vicinity of the O.P. as there were many French infantry officers near in addition to the French observers—all N.C.O's. So useful had we proved ourselves that the French paid us the compliment of providing us with one of their coveted observa-

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tion of fire instruments. We wished we could have borrowed it indefinitely the field of view was wide and the definition remarkable. Both in weapons and optical instruments the French seem to be ahead of us. Their heavy howitzers are drawn by F.W.Ds. and are wonderfully mobile, much of their mobility being due to the excellence of the gun mounting and their rubber-tyred wheels. The French too spare their horses in every way. Their field guns and field howitzers accomplish the major portion of their journeys on specially constructed lorries or trucks on the railways: their horses obviously inferior to ours suffer far less from exhaustion in consequence.

Our men profited considerably by their short spell of fighting with the French. Much of their self-complacency vanished. They seemed astonished at the Frenchman's capacity for work and his adaptability to his circumstances and environment. They noted with just a touch of envy the responsibility rested in the French gunner N.C.O. and I think that with a little more encouragement our N.C.O's might be more trusted with great advantage to our artillery. We trust them now but only more or less on sufferance, or as a stop gap when "needs-must".

It was with genuine regret that our batteries withdrew to the rest area for re-fitting. Before we left we were paid the handsomest compliments by our group and divisional commanders, both of whom seemed really grateful for the assistance we had given them during a somewhat trying time. Our parting with the French observers was eloquent testimony to the efficacy of our fire and our ready responsiveness to the many calls made upon us from time to time.

The establishment of the unity of the allied command under their own general was hailed with delight and possibly accounted for some of the expansiveness of their expressions of gratitude. On our part we were surprised at the smoothness with which their artillery machine is worked, and the attention paid to the smallest details of battery organization—above all, at the smallness of the staff which promotes such efficiency.

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THE SIMPLEST & MOST ACCURATE FORM OF GRID.

By Major E. H. Lovell, R.G.A.

MANY forms of Grids have been tried and used in the Siege Artillery since the war commenced. Hill's Plotter which is the official one now issued for general use is very neat and handy. Grose's Grid is entirely on the same principle as the one to be described which the author made and used first in February 1916. It is of very simple form and was very successfully used at home and on service being both quick and accurate. With the latest ideas in shooting by double line observation it is particularly useful. In fact it is serviceable for any form of shooting. The only objection to it is that a little care and trouble has originally to be exercised in making it which some officers object to and also the multiplicity of slips. Once made however, they may be used to take endless copies, off. A neat draughtsman with trifling calculations can make them in an hour for any battery and they can be used for years. The objection, to it, as a universal pattern is, as I have stated above, that a special slip is required for each charge and for great accuracy for every 500 yards of range. The few B.C's I showed it to were greatly taken with it and it was also shown to the Commandant, School of Gunnery, Lydd. If however you care to eliminate extreme accuracy one grid for every 1500 or 2000 yards is sufficient. I use the word extreme accuracy purposely as I am an extremist in this way particularly for siege work. With our splendid type of modern howitzers and their beautiful mountings and sights, accuracy should be always aimed at. Slap dash methods are strongly to be deprecated. You may say a round or two is not worth saving for accuracy's sake, but it is, particularly for training and preliminary instruction. In mobile warfare slap dash methods may be excused and are probably sound in quick moving actions.

To describe the plotter and Grid. It can be used for either single or double line observation at any O.P. Range or apex angles. The factors are automatically and accurately found for you and eliminate entirely the use of the slide rule. The exact corrections for deflection and elevation can be read off. The corrections are in minutes so no conversion from yards to minutes of gun deflection or elevation is necessary. In Hill's plotter which of course has the great advantage of being serviceable for all guns and charges you have to convert from yards to minutes by means of 2 circular converters,

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this means time and also factors have to be calculated. My grid obviates this and merely graphically represents the range table on celluloid strips with 2, 1/10000 scale celluloid rulers and 2 large protractors, of course it cannot be used conveniently at the O.P. nor can Hill's plotter, the less you carry to the O.P. the better. You have a good dug-out at the battery as a rule with a table and excellent maps, 1/10000 scale maps are the best and can always be obtained, I never used anything else in France. They give you the most accurate results. The 1/20000 Planchette issued by the R.E. is the official size, but to my mind, for really the best results, not big enough. For 6 weeks on the Somme, when the battery was with the French, I used 1/10000 metre maps. The 1/20000 to a great number of B.C's is good enough but I prefer greater accuracy and don't believe taking calculations to the nearest anything or in haphazard work if it can be avoided. It is all very well to say that the 50% zone of a gun ought to be considered and that errors in calculation of factors etc. may be made to within this zone, but why not consider it to its minutest figure. A small error may throw your M.P.I. just off the target and you want to avoid this.

To revert to the instrument. Take any range table say 9·2″ Howitzer 2nd charge, ranges 6000—6500^{x} for example. Cut out slips, fram the celluloid sheets issued, into sizes about 5 inches by 3 inches, the length being a good deal more than the breadth, as a gun or howitzer is more accurate for line than range or elevation. Set a needle or a pin into a holder and with this make 2 lines crossing at right angles, down and across the centre of the slip.

On these lines you now mark your readings calculated straight from the Range table. This is your grid.

If you wish for extreme accuracy, these slips had better be made for every 500 yards of range.

To give an example. Make a slip for ranges between 6000—6500 yards.

Take the mean of these which is 6250^{x}.

Look at the column for 5′ E for this range and for 5′ D. Say 5′ E = 20^{x} and 5′ D = 10^{x}. 5% zones 60^{x} and 12^{x}.

Now if you are making out the slip for a scale of $\frac{1}{10000}$ your calculations must be to this scale.

Taking the Elevation line first. Your 50% zone being 60^{x}, the S.B. is 120 yards which equals 30 minutes. Therefore 30 minutes is a convenient size for marking, as during Ranging this will be the bracket you will aim for. As 30′ = 120^{x} at a scale of 1/10000 this will be equal to ·43 inches on paper.

This is a very large distance on paper for the eye to see and really could conveniently be halved, giving 15′ readings. Now with a hair compass read off ·43 inches off your protractor and mark say up to 4 or 5 divisions on the elevation line each side of the centre, this will give you 2° or 2° ·30 each way for observations plus or minus. Similarly mark with your needle the deflection line. If the distances are large, as in this case, you can safely interpolate. Now mark in your 50% zone as a rectangle. Figure in the marks and also the minutes and degrees against these marks and then write

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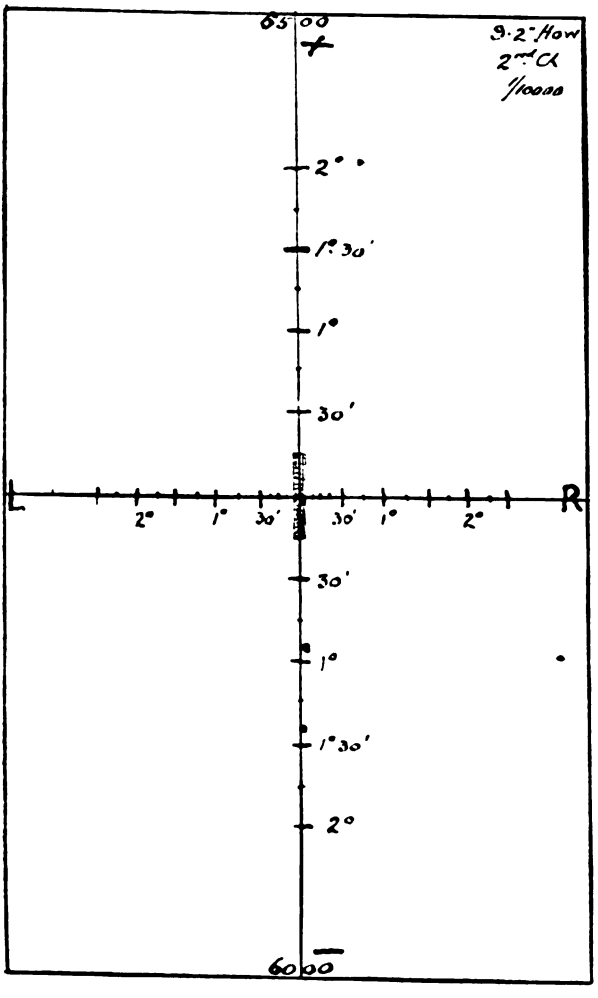
over them with a fine pen of indian ink (if possible). You will find the figures will stand out clearly and will not rub out easily. If they do they can be put in again.

Make out these celluloid slips, or make your B.C.A. do it if you have a good one, for all charges and every 500 yards of range and put them into envelopes and tabulate them. In addition make out paper slip copies by the dozen on which you can plot your shoots for record. For important shoots this is very useful and you can see from day to day what your guns have been doing, in fact, if carefully kept are a perfect record of your guns shooting from which you can easily work out losses of M.V. and see how your shell have fallen with reference to target and the M.P.I. It is all on your ranging sheet of course, but these graphical slips tell your eye in a second what your guns have done.



CELLULOID STRIP

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They are also handy in case a copy of any shoot is required by Brigade or Corps H.Q.

To work the Grid.

Set your celluloid slip for the particular charge and range, with the centre of the slip over the target or Ranging point on your map, the E line must be placed on the B.T. Line.

Then put your large semicircular protractors on the O.Ps. or O.P., the centre of arc on the O.P. itself and the zero line on the O.T. line. The larger protractors are better as they are graduated more finely to minutes. Better still set the little celluloid 5° arcs issued to the battery, at the range for which they are made out, with the centre or zero line on the O.T. line and then place your celluloid rulers with a pin on the O.P. If double line observation is used, set both arcs or protractors and rulers one of each on each O.P. Now having set everything ready, have your paper slip, on which a picture of target and surroundings is drawn, pinned to your right hand side. On centre of slip is the target properly drawn with relation to battery line. Mark shell falls in 50% zone in Red, remainder in black or blue. An observation now comes in from R.O. 2° Right and from L.O. 3° L. Set your rulers at these readings on your protractors or arcs and where they intersect on the celluloid slip, is the exact fall of the shell. This can easily be read off in minutes of G.E. or Deflection and the exact correction given straight away to the battery. Plot the fall of the shell on your paper slip and go on doing this till the end of your shoot. With single line observation, the procedure is similar. (See Diagram facing page 172).

If using single line observation, the exact correction necessary can be given according as to whether you intend using the E or the D factor, these factors are automatically given you on the celluloid grid over your target on the map. See Diagram II.

If your rulers get lost or broken, cotton is good enough. The great advantages of this grid are, it is easy to make but requires a little care, it is accurate and there is little expense incurred. If you do not care to buy the scale rulers cotton is equally useful. The rulers being graduated to scale in yards are of course a great advantage. The celluloid arcs and protractors are essential of course, but these are issued.

If the Hill's plotter is destroyed or damaged in any way the above could be used, until a fresh one is issued. An alternative, which I used sometimes, to the above celluloid separate grids, was one long celluloid sector grid, with rays to 5° on each side of zero and arcs every 500 yards. On these arcs and on the centre or zero ray, a graduated series of corrections in minutes from the range table for deflection and elevation was marked and adjusted to the 50% zones. A Red line was put on at the Range where it was necessary to change to the next highest charge. It has however the great disadvantage of being very troublesome and tedious to make out but it has on the other hand the advantage of being all in one for all ranges and charges for one type of howitzer.

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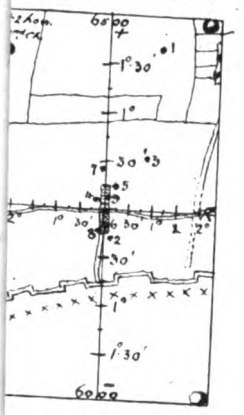
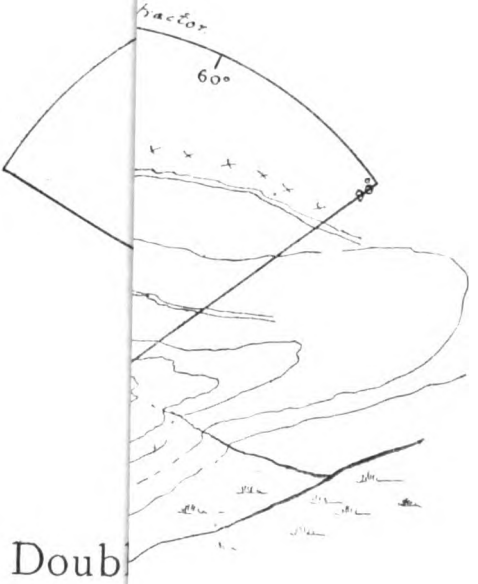
Paper Slip with Picture of Target. Rounds dotted on.





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SPORT IN MESOPOTAMIA.

By Brig.-Genl. H. J. A. Mackey, c.m.g., m.v.o., d.s.o.

THE possibilities of Mesopotamia as a sporting country are apparent to the most casual observer who travels by river steamer from Basra to Baghdad, at any rate during the winter months. All day long duck, teal, geese and sandgrouse will be on the move, whilst in the early morning and evening black partridge can be heard calling from the scrub by the banks.

Mesopotamia however is a land of extremes, the heat of summer is almost unbearable, and for months one longs for the rain, which, when it comes, seldom knows when to leave off, and turns what was a simple dust heap into a slough of despond which practically suspends all movement. As with the climate, so it is with sport, for the moment one gets away from the immediate vicinity of water, all vegetation disappears and one is in a barren and desolate desert, where the only form of life, other than flies, lizards and scorpions, are the sandgrouse and the jackal.

Coming up the Tigris, after passing Amarah, broadly speaking the country consists of a narrow strip of scrub along the banks of the river, and beyond that desert. Further up, from Kut onwards, this strip tends to widen, and there is more cultivation, until one comes to the very fertile part round Baghdad and up the Dialah. It was therefore, not until after the capture of Baghdad, that the full possibilities of Mesopotamia as a sporting country were realised.

Apart from polo and racing, the following forms of sport are all to be had in varying degrees of excellence—Hunting, Shooting, Pig-sticking, and Fishing.

Hunting, has been carried on with a small pack of Fox-hounds as well as with long dogs and bobbery packs. Two varieties of fox are found here, but as a rule the jackal is the quarry. The jackal of Mesopotamia is a much larger animal than the Indian jackal and grows a very thick coat, and when driven to bay puts up a good fight. At the beginning of the season when all the water cuts were dry, they were much inclined to stick to the nullahs, but later they proved to be very straight necked sporting customers.

The small red fox of the plains is met with occasionally, but much more common is the big silver fox of the hills. Unfortunately the latter is almost invariably found in the hills where the going is so stony that one would very soon cut all hounds feet to bits.

Irrigation channels of varying sizes with spoil banks on either side are the most common obstacles, and one needs a horse that can not only gallop, but looks where he puts his feet. A great deal of the country is black cotton soil and very rotten after rain.

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Shooting is very good and variety considerable. The following have been shot in one Divisional area this season:—

Greater Bustard.	Quail.
Lesser Bustard.	Black Partridge.
Imperial Sandgrouse.	Woodcock.
Painted Sandgrouse.	Sisi.
Goose.	Chikor.
Duck, in great variety.	Blue Rock Pigeon.*
Teal.	Wood Pigeon.*
Snipe.	Hare.
Green Plover.	

The greater bustard is very local and not many have been bagged, the lesser bustard being considerably more common.

The most usual goose is the grey leg, but late in the season the white fronted goose, very like a barnacle goose was common.

Of duck, mallard, pintail, widgeon and pochards of various sorts were most common. Flighting yielded best results for duck and geese.

The only quail the writer has actually seen out here is the small bushquail, a poor bird either to shoot or eat.

Black partridge are very plentiful, and afford great sport when driven. Some of the best shooting is to be got by driving them over the mud walls of the date gardens.

Sisi are very numerous in parts of the Jebel Hamrin and throughout the low hills, whilst higher up chikor are abundant.

Woodcock are of frequent occurrence within 60 miles of Baghdad, and in the hills are plentiful.

The hare is a great improvement on the Indian hare, and cases have frequently occurred of their getting right away from a long dog.

Larger game, leopard, bear etc., abound in the Persian hills, but that is getting beyond the scope of this article; but the Persian gazelle is common in the foothills, a very shy animal and to judge by his habits has been well chivied ever since the days of Esau.

Pigsticking. Pig are very plentiful but local, they run large and are good fighters.

Fishing. The fish par excellence here is the Asiatic carp, which runs very large. The largest the writer can actually guarantee was length 6 feet 4 in., girth 34 inches, estimated weight 180—200 lbs This fish had been speared by an Arab. They take a spoon and very strong tackle is necessary. There is reason to hope that when the hill streams are clear of snow water, smaller fish may be taken on the fly in these streams.

In conclusion, this is not intended to be a scientific and exhaustive treatise on the fauna of Mesopotamia, but it is hoped that it may give some idea of the country to officers of the Regiment coming out here. Much that is bad has been said of Mesopotamia, but given peace conditions and the ordinary comforts and conveniences of an Indian cantonment Mesopotamia would be a far better place in which to be stationed than the majority of Indian stations. But keep north of Amara, and avoid the towns.

* Pigeon shooting is now prohibited.

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Short Chronology of events connected with the *matériel* of Artillery, down to the year 1886.

By Lieut.-Col. H. W. L. Hime.

[*p* refers to the pages of the "Origin of Artillery" *c* stands for *circiter*.]

B.C.

c. 750	Fire Arrows known to the Jews; Proverbs, XXVI, 18; Isaiah L, 11. Gesenius, "Heb. Lexicon", under *Zikkim*.
413	Fire Ship used by the Syracusians. Thucydides, VII, 53.
54	Hot Balls of clay used by the Britons. Cæsar, "de Bell. Gall.", V, 43.

A.D.

673	Greek (Sea) Fire invented by Kallinikos, a Greek; p. 29.
904	Handgrenades (earthenware) at siege of Salonica; p. 140.
1225–48	Saltpetre discovered; p. 24.
1248	Gunpowder ('Serpentine' or ungrained) invented by Friar Roger Bacon; p. 116.
,,	Rockets, with bursting charges, made by Friar Bacon; p. 113.
1275–95	Fuzes used by Arabs; p. 202.
1313	Cannon invented by an unknown German monk; p. 120.
1314	Cannon introduced into England; p. 127.
c. 1350	Cast Iron invented, most probably in Sussex.
c. 1382	'Dulle Griete', the monster bombard of Ghent constructed; p. 126.
1419–24	Howitzers constructed during Hussite wars.
1429	Corned (grained) gunpowder mentioned by Conrad von Schongau; p. 154.
1439	Case shot used at the siege of Belgrade; p. 179.
1461–83	"The Twelve Peers of France", among the earliest bronze guns constructed, the earlier guns having been wrought iron.
1463	An Incendiary Shell invented by Valturio; p. 192.
c. 1483	Gun Carts gradually superseded by Gun Carriages.
c. 1495	Single Shot, the size of the bore, began to be used; p.173*n*.
c. 1500	A Gunners' Quadrant invented by the Emperor Maximilian I. Jähns, "Handb. Gesch. d. Kriegsw.", 812.
1535	Brass Ordnance first made in England by John Owin. Stow's "Annals", p. 571.
1543	Cast Iron Ordnance first made in England at Buckesteed in Sussex by Hoge and Baude. Holinshed's "Chronicles", II, 960.
,,	Cast Iron Mortars, 11″ to 19″, to discharge Explosive Shell, made in England by Baude and Collet; p. 196.

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1560	Cartridges (for cannon) recommended by Whitehorne; p. 151.
„	English Gunpowder strengthened; p. 168, Table VII.
c. 1575	Corned powder gradually supersedes Serpentine; p. 155.
c. 1578	Elevating Screw (for gun) invented by John Skinner, one of the Queenes Majesties men". Master Gunner W. Bourne, "Inventions and Devices", 1578, p. 39.
„	The Gunners' Rule, a makeshift for a tangent scale, mentioned by the same Master Gunner.
1579	Hot Shot (for guns) introduced by Stephen Bathory, King of Poland; p. 173.
1588	Arrows used in muskets in Drake's fleet; p. 171.
„	Explosive Shell used in large numbers and good effect at Bergen-op-Zoom and Wachtendonck; p. 197.
1596	Adjustment of Fuzes to burn a certain time recommended by Sebastien Hälle; p. 210.
1628	A Leather Gun invented by Col. Robt. Scott. Proceed. of the R.A. Institution"; v. XXV.
1647	Mortar Eprouvette proposed by Master Gunner N. Nye; p. 164.
1655	Percussion Powders discussed by Glauber; p. 216.
1670	English Gunpowder further strengthened; p. 168, Table VII.
1672	Carcasses invented; p. 194.
1684	Glazing Gunpowder mentioned by Mieth; p. 154*n*.
1698	Steam Pump for mines invented by Savery.
1713	Coal introduced by Darby (after years of opposition) for the manufacture of iron. Scrivener, "Hist. Iron Trade", p. 89.
1742	Ballistic Pendulum invented by Robins; p. 165.
1760	Steam Bellows for mines invented by Smeaton.
1775–1800	Tangent Scales, Equalisation of Wheels, Pintail and Trail-plate Eye, and Block Trail, introduced in our Field Artillery.
1776	Rifled (1 Pr.) Gun, with Telescopic Sights, constructed by Dr. Lind, Edinb., and Capt. A. Blair, 69th Regt. "R.A Journal", XL, 172.
1776	Gribeauval introduces Tangent Scales in France.
1778	Gun Flintlock invented by Capt. Sir C. Douglas, R.N., p. 201.
1781	English Gunpowder reaches its final composition, 75 Saltp., 15 Char., 10 Sulph. p. 168.
1783–4	Cort's patents for Puddling and Rolling Iron.
1784	Shrapnel Shell invented by Capt. Lieut. Henry Shrapnel, R.A. (adopted in 1803); p. 183.
1792	6 Pr. Rifled Gun and 6 Pr. S.B. competion at Goodwood; "R.A. Journal", XL, 167.
1800	Fulminate of Mercury discovered by Howard; p. 216.
„	Baker's Rifle issued to Rifle Brigade on formation.
1805	Congreve Rockets introduced; p. 147.
1807	Percussion Powder for priming, proposed by Rev. A. Forsyth; p. 216.

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1815 Gunpowder Manufacture reorganised by Sir W. Congreve.
1818 Percussion Cap invented by Col. Peter Hawker; p. 216.
1829 Dispart Sights, invented by Col. W. Millar, R.A., introduced into R.N.
1838 Steam Hammer invented by Mr. Nasmyth.
1840 Electro-magnetic Chronoscope invented by Sir Charles Wheatstone; p. 165.
1842 The Percussion Musket introduced.
1846 Dispart Sights (Millar's) introduced into R.A.
1849 Wooden Time Fuze invented by Capt. E. M. Boxer, R.A. p. 215.
1850 Percussion Fuze invented by Commander Moorsom, R.N. p. 217.
1853 Friction Tube invented by Mr. Tozer, Rl. Laboratory; p. 202.
1855 Enfield Rifle introduced.
1856 Conversion of Cast Iron into Steel by method invented by Mr. Bessemer.
1859 Breechloading Rifled Guns (Armstrong's) introduced.
1860 Regenerating Furnace invented by Mr. Siemens.
1861 Indenting Apparatus and Internal Pressure Gauge invented by Capt. T. J. Rodman, U.S. Army.
1864 Disappearing Gun Carriage invented by Sir A. Moncrieff.
1864-70 Prof. F. Bashforth's Reports on Experiments with his Chronograph.
1866 Muzzleloading Rifled Guns displace Breechloaders.
1868 Range Finder invented by Capt. J. P. Nolan, R.A.
1875-80 Researches in internal ballistics by Sir A. Noble and Sir F. Abel in "Phil. Trans."
1878 Telescopic Sights invented by Major L. K. Scott, R.E.
„ Fuze Setter invented by Vet. Surg. A. E. Clarke, R.H.A.
1883 Sir G. Greenhill determines the conditions for wabbling of a projectile.
1886 Breechloading Guns supersede Muzzleloaders.
„ Nitrocellulose explosive invented by M. Vieille, followed by Cordite &c., and the Gunpowder Period closes.

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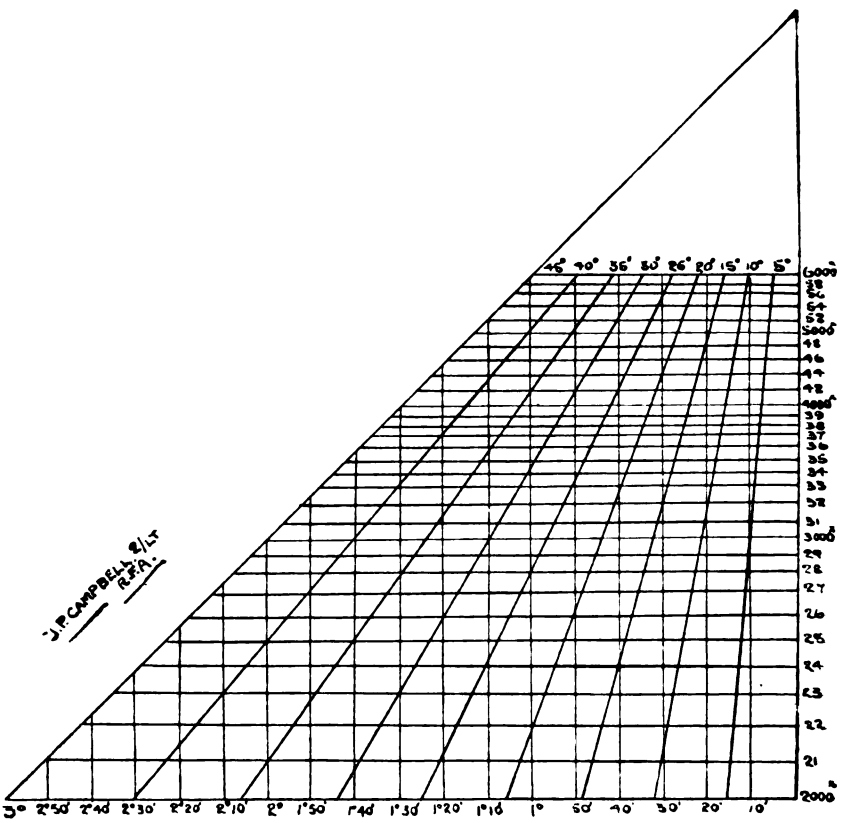
RANGING ON THE LINE OF OBSERVATION.

By Temp. 2nd Lieut. J. P. Campbell, R.F.A.

THE various methods of finding the factors employed in the above system of ranging are fully described in the pamphlet "Notes on Gunnery" of May this year issued under 40/W.O./5865 and it is proposed in this article to discuss only the last method suggested which is that of finding the factor $\frac{D}{E}$ graphically without the aid of the plotter, observation of fire, No. 1, Mark 1. This is done by drawing BTO with the required apex angle, scaling off a hundred yards along the line TB and with a line at right angles connecting it with OT. This distance is then measured with the scale previously used, the number of yards being afterwards converted



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into minutes deflection for the particular range required. Every time a fresh target is engaged, this procedure has to be repeated, the attached diagram is therefore suggested with a view to obviating such repetition. The triangle is drawn out to represent BTO, BT being scaled off into various ranges from 2000 to 6000 yards. From the point T, radiating lines are set out every five degrees to represent apex angles and red lines drawn perpendicular to the base at regular intervals indicate the number of minutes deflection required for every hundred yards increase or decrease in range. To read the diagram it is only necessary to note where the particular range and apex angle intersect and to read off on the scale at the base of the diagram the number of minutes vertically below this intersection. In the event of the range being altered to any considerable extent, the new $\frac{D}{E}$ factor can be seen at a glance without any further calculations. The diagram shown is made out for apex angles up to 45° (this will cover the majority of requirements) but it could be extended if necessary up to 65°.

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DISTRIBUTION OR CONCENTRATION RULE.

By Temp 2nd Lieut. J. P. Campbell, R.F.A.

THE Rule shown in the accompanying diagram was made by the writer with a view to facilitating the working out of concentration or distribution for various ranges and extents of targets, and with regular or irregular gun intervals. The Rule is divided into four sections, the first being made out for 20 yard intervals and incidently covering 10 and 40 yard intervals, the second for 30 or 15 yard intervals, the third for 25 or 50 yard intervals and the fourth for 35 yard intervals. On the left hand side of the Rule are marked the various ranges for BT from 1000 to 7000 yards and on the opposite side are the different divisions representing minutes concentration or distribution. In the centre is fitted a sliding scale marked with extents of target from zero to 5° and on the right hand side of the scale an arrow is marked for use as an indicator. To find the concentration or distribution the sliding scale is moved until the extent of the target which is being engaged is opposite the required range and read off against the arrow the minutes concentration or distribution necessary. For example, if the range BT is 3000 yards, the extent of the target 3° and the guns have regular intervals of 20 yards. Move the sliding scale until the 3° extent of target comes opposite the range 3000 yards and against the arrow we read that 6 minutes distribution is required. The section dealing with 20 yard intervals is also applicable to 10 and 40 yard intervals but the range should be halved for 10 yard and doubled for 40 yard intervals. Thus in the above example, if the interval was 10 yards the 3° on the sliding scale would be placed opposite 1500 yards range instead of 3000 yards, or for a 40 yard interval against 6000 yards which would then give the correct concentration or distribution. This applies also to the 30 or 15 yard interval and the 25 or 50 yard interval sections.

If irregular intervals are being worked out the concentration or distribution for the previous gun or guns has to be added to that for the remaining flank guns. For example, if the range is 3000 yards, the extent of the target 3°, and irregular intervals of 10 yards between Nos. 1 and 2 guns, 35 yards between Nos. 2 and 3, 15 yards between Nos. 3 and 4, 20 yards between Nos. 4 and 5, and 25 yards between Nos. 5 and 6 guns. From the Rule we find that No. 2 requires 18′ distribution, No. 3 requires 13′ concentration, No. 4 requires 12′ distribution, No. 5 needs 6′ distribution and No. 6 is correct.

This concentration or distribution is based on each gun having a parallel line of fire to its right hand flank gun before correction so that in the above example the B.C. would order No. 2—18′ more left, No. 3—5′ more left (18′ dist. minus 13′ concen.) No. 4—17′ more left, No. 5—23′ more left, and No. 6—23′ more left. The Rule is made out for a six-gun battery only.

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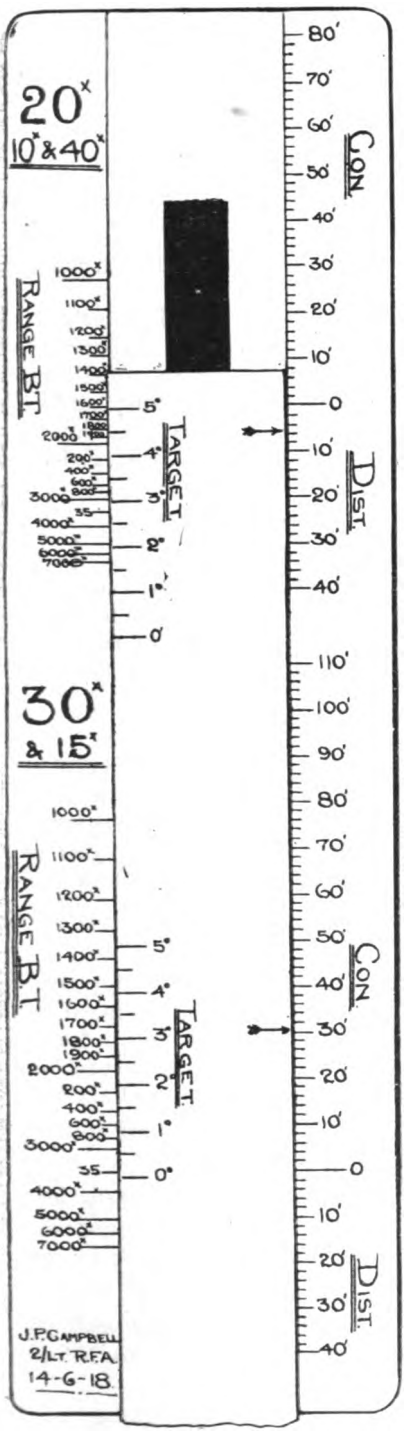

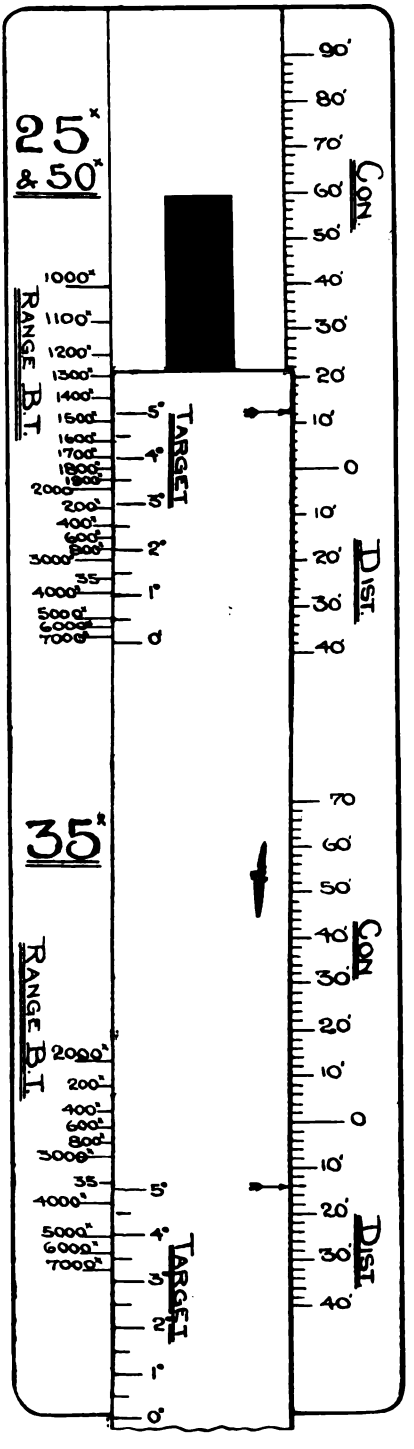

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THE GUNNER'S RULE.

BY "NEWLY FLEDGED".

THE writer desires to belong to the most up-to-date school of gunnery provided it is also the most effective.

Having read with interest the remarks by Sagittarius in the May number of the R.A. Journal on the advantages of the "Gunner's" or "36" Rule, which is still a favourite apparently with some Senior Officers, he determined to satisfy an old standing curiosity as to the relative degrees of inexactitude of the various rules i.e. the "34" Rule, or "3·4" Rule as Lydd prefer to term it, the "35" Rule and the "36" Rule, which are alike based on the formula:—

$$\text{Apex angle in Mins.} = \frac{\text{Base}^{\frac{1}{2}} \times 3438}{\text{Range}^{\frac{1}{2}}}$$

Doubtless a comparison of these rules has been worked out many a time previously, and in your paper, but the writer has not as yet come across one, and readers may be interested in the results he obtained. These are shown in the attached table, and were obtained by the use of a slide rule.

It will be seen that:

(1). Using the most correct multiplier possible i.e. 34·38, the variation in length of Base from True, does not amount to the equivalent of 5′ Gun Deflection until the apex angle approximates 9°. Or, conversely, given your Base, the rule should give you your apex angle correct within 5′ unless the apex angle approximates 9°.

(2). Using 34 (or 3·4) as multiplier, an even better result is obtained because:—

(a). Owing to the figure being slightly less than the correct multiplier 34·38, a *plus* error is at first obtained which more than counterbalances the negative error inherent in the basic formula (see column II) but at no point quite reaches the equivalent of 5′ Gun Deflection. It nearly does so when the apex angle is round about 7°.

(b). A negative error equivalent to 5′ S.D. is not obtained until the apex angle approximates 12°!

(3). With "35" as multiplier the results are decidedly worse than in either of the two foregoing cases. An error equivalent to 5′ S.D. is reached with apex angle of 4°, and to 10′ S.D. with apex angle of 7°.

(4). With "36" as multiplier 5′ S.D. error is reached with apex angle of only 2°, and the amount of error rapidly rises to 15′ with apex angle of 5°, 25′ with apex angle of 8°.

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1. Roughly therefore it may be said that the "36" Rule is twice as inexact as the "35" Rule, and more than gun time as inexact as the "34" Rule.

2. It must be remembered that in rough working without slide rule the error inherent in the "36" rule will be exaggerated under the law of averages in one case out of two.

3. The "34" Rule can be applied in every case where the "36" Rule can be.

4. The writer has not unfortunately the advantage of practical experience at the front, but by using either "34" or "35" as multiplier indifferently, whichever is more convenient, it should apparently be possible to approximate results mentally as quickly as, and more accurately than, by rigidly adhering to the multiplier "36".

5. It is just as easy to remember the number "34" as the number "36"!

On the whole therefore may not the "newly fledged" be well advised to stick to their "34", with or without their note books in addition?

No. of Yards in Base subtended at Range of 1000 yards as obtained by

Apex Angle.	I	*a* II *b*		*a* III *b*		*a* IV *b*		*a* V *b*	
	Table I. Natural Tangents. (True Base) yds.	34·38 Rule.		3·4 Rule.		35 Rule.		36 Rule.	
		yds.	Error from True.	yds.	Error from True.	yds.	Error from True.	yds.	Error from True.
° ′									
5	1·45	1·45	—	1·47	—	1·43	—	1·39	—
30	8·7	8·7	—	8·8	+ ·1	8·5	− ·2	8·3	− ·4
1	17·5	17·4	− ·1	17·6	+ ·2	17·2	− ·3	16·6	− ·9
2	34·9	34·7	− ·2	35·2	+ ·3	34·3	− ·6	33·6	− 1·3
3	52·4	32·1	− ·3	53	+ ·6	51·3	−1·1	50	− 2·4
4	69·9	69·5	− ·4	70	+ ·1	68·5	−1·4	66·5	− 3·4
5	87·5	87·1	− ·4	88	+ ·5	85·5	−2·0	83·1	− 4·4
6	105·1	104·3	− ·8	106	+ ·9	103	−2·1	100	− 5·1
7	122·8	122	− ·8	124	+1·2	120	−2·8	116·2	− 6·6
8	140·5	139·9	− ·6	141	+ ·5	137	−3·5	133	− 7·5
9	158·4	157	−1·4	159	+ ·6	154	−4·4	150	− 8·4
10	176·3	173·9	−1·4	176	− ·3	171	−5·3	167	− 9·3
11	194·4	192	−2·4	194	− ·4	188	−6·4	184	−10·4
12	212·6	209	−3·6	211	−1·6	206	−6·6	200	−12·6

* $\frac{\text{Base}}{\text{Range}}$ tan Apex Angle, whence Base = 1000 × tan apex angle

e.g. 1000 × tan (1°)
= 1000 × ·0175
= 17·5

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Note 1.—The extent of error in Gun Deflection represented, will be the same at all ranges e.g. Error in Base by 3438 Rule at 1000 yards Range = $1{\cdot}4^{\underline{x}}$ = 5′ Gun Deflection. Error at 5000 yards will be $7^{\underline{x}}$, = 5′ Gun Deflection as before.

Note 2.—Slide Rule set as follows:

$$\frac{1}{\text{Base}} = \frac{3438\ (34\ \&c.)}{5,\ 30,\ 60,\ 120\ \&c.}$$

$$\text{(since No. of mins. (5, 30, 60, \&c.)} = \frac{\text{Base} \times 3438\ \text{(or 34 \&c.)}}{\text{Range (taken as 1)}}$$

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THE GUNNER'S RULE.

BY SAGITTARIUS SECUNDUS.

THE writer belongs to the same school as Sagittarius. But that school is large enough to include more methods than one of applying the same principle. This principle is "Use one formula only". His rule is "Reduce the error to inches", etc.

My rule is:

$$\frac{60 \times \text{Base}}{\text{Range}}$$

I claim for mine

(1) It is easier to remember than any other, because 60 is the basic figure on which all displacement formulæ in the field are founded (circular measure). The same unit of measurement is taken in numerator and denominator. There is no mixture of inches and yards, or yards and feet, or yards and hundreds of yards, or $\frac{6}{10}$ of anything.

(2) The answer comes out in degrees, not in minutes.

(3) It can be done in inches in the head. Don't worry about the noughts. If the 1st figure of the answer is 2, it is obvious whether the correct answer is 2° or 20° or 200°

Take the example Sagittarius finds us

Base 100^{x}
Range 2000^{x}

His sum is: =

$$\frac{100 \times 36}{20} = 180' = \frac{180^\circ}{60} = 3^\circ$$

My sum is $3 \times 1 = 3^\circ$.

Which is the quicker? Which can be done most easily in the head, the one which involves the figure 36 in every sum, or the one which involves the figure 6 in every sum?

(4) The 60 rule keeps prominent the origin of the formula, namely that $\frac{1}{60} = 1^\circ$ (approx).

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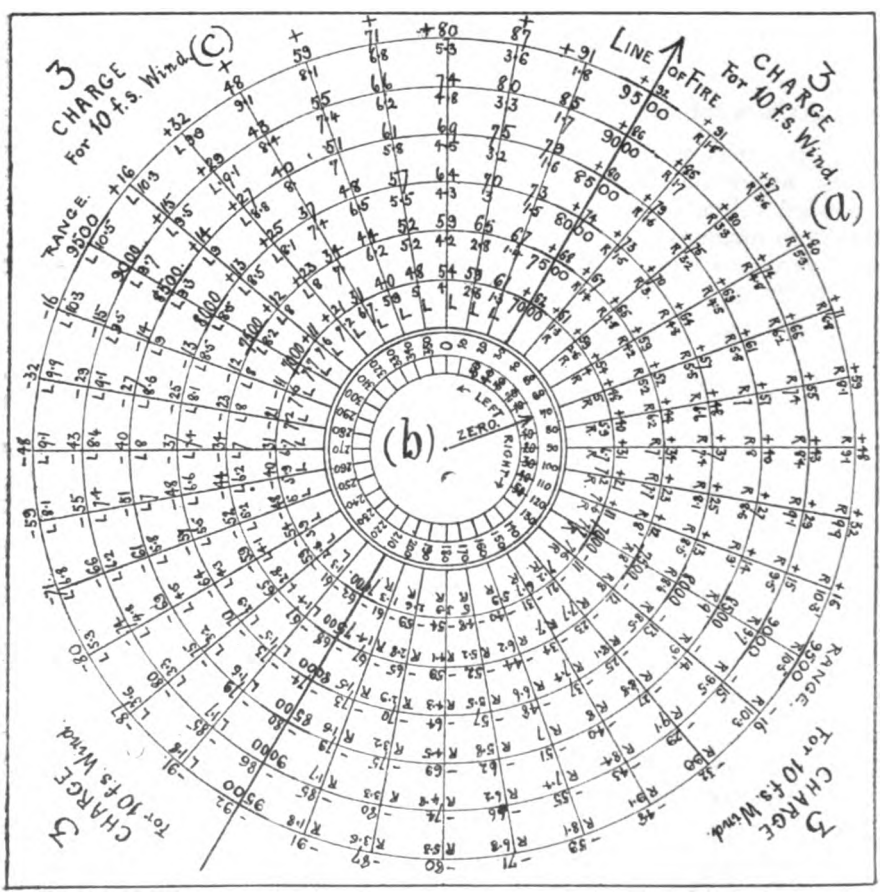
READY RECKONER FOR WIND CORRECTIONS.

By 2nd Lieut. F. G. Witts, R.G.A.

THE following card with the re-arrangement of the figures given in Range Tables has been found useful for reducing calculation and chances of error and for saving time in finding the corrections for wind.



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The wind-card once the figures are entered in, finds automatically the angle between the bearing of the wind and the line of fire for any switch from zero-line and the correction in elevation (yards + or −) and deflection (minutes R or L) for any range.

A separate wind-card is required for each charge.

The illustration given is of a wind card, for Charge 3, of a battery having a zero-line of 70° Grid.

N.B. The figures given are only typical, the actual corrections are obtained from the Range Table in use and entered on the card for the particular zero-line of the battery. The inner circular card marked (b) revolves inside the outer square card marked (a).

The illustration shows the card set for a target at a switch of 40° Left from Zero Line.

Let Meteor give the wind as 25 f.s. and the Bearing of the wind as 330, the corrections for any range appear opposite the bearing 330 on the line marked C for a 10 f.s. wind. Let the range be 8000 yds. The wind correction is + 37 yds. and 7·4′ Left for a 10 f.s. wind, i.e. + 93 yds. and 18·5′ Left for a 25 f.s. wind.

The device can be easily improvised from two pieces of stiff card 9″ square.

The two cards will be fixed one on top of the other. The revolving disc (b) will be cut out of the top card (radius 1¼″) and will be attached to the bottom card by a fastener or drawing pin at the centre so that it can be revolved inside the card from which it was originally cut out. The top and bottom cards should then be pasted or gummed together. The concentric circles of card (a) should be ½″ distance from one another. On both (a) and (b) lines radiate from the centre every 10°. The grid bearings are marked only on the outer edge of (b).

On (a) mark clearly the Line of Fire and on (b) the Zero line of the Battery and Switches in degrees Left and Right as shown.

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BUILT-IN BEAMS IN DUG OUTS.

By Temp. Lieut. E. S. Stanley, R.G.A.

WITH regard to the article in the June number of the Journal, entitled "Calculations necessary for the construction of dug outs and gun pits," I should like to point out that great caution is necessary in the use of the formula No. 5 for built-in beams. As this will only hold good if the beam is so firmly built in at both ends as to prevent the ends turning at all from their original position, which is often difficult to accomplish in the field.

If the ends are able to move to a slight extent the beam will not carry the full load given by this formula, but will more nearly approximate to formula No. 4 for a beam merely supported at both ends. And as it is usually difficult to make certain of the beam being really firmly built in, it is safer to always use this formula; (No. 4).

This is the reason I believe why the formula for built-in beams is not given in either G.A.T. or Field Engineering.

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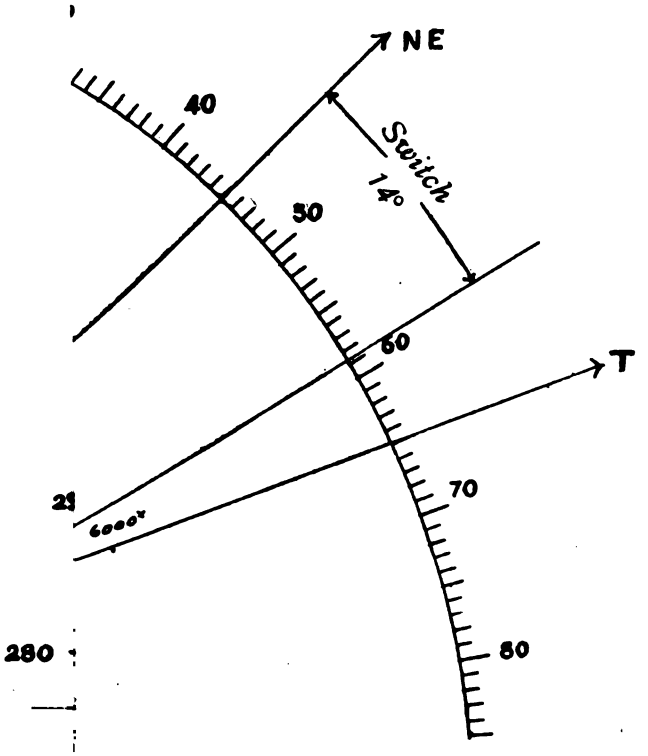

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Contents of R.A. Journal, September, 1918.

Sums in the Field. By Major S. R. Wason, M.C., R.H.A..... 189

Oblique Observation. By Major S. R. Wason, M.C., R.H.A.... 197

Notes on the use of Major Swayne's Sheets. By Major C. E. Hare, M.C., R.G.A. 201

Simplest Form of Field Plotter for Quick Work in the Field. (Position on Map being unknown). By Bt.-Col. A. ff. Powell, D.S.O., R.G.A. 203

Correction to Range when Firing with Angle of Sight. By 2nd Lieut. F. G. Soper, R.G.A. 205

Ordnance on the Allied Front. Developments in Artillery During the War. By Major-General J. E. W. Headlam, C.B., D.S.O., in Charge of the British Artillery Mission to America. 209

Authors are alone responsible for facts and opinions expressed in their papers.

Note.—Owing to the "Leaflet" accompanying this Journal being corrected up to the last day of the month, and abnormal conditions due to the war, publication will not take place for a further 14 days.

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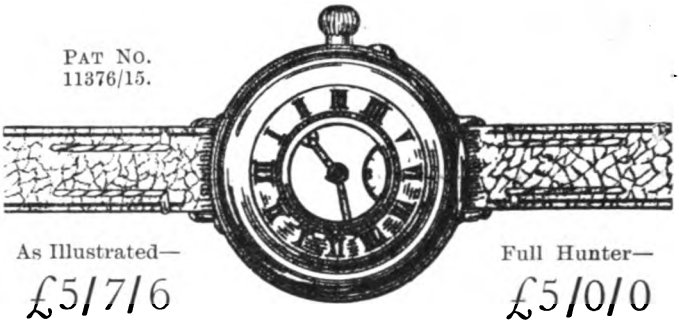

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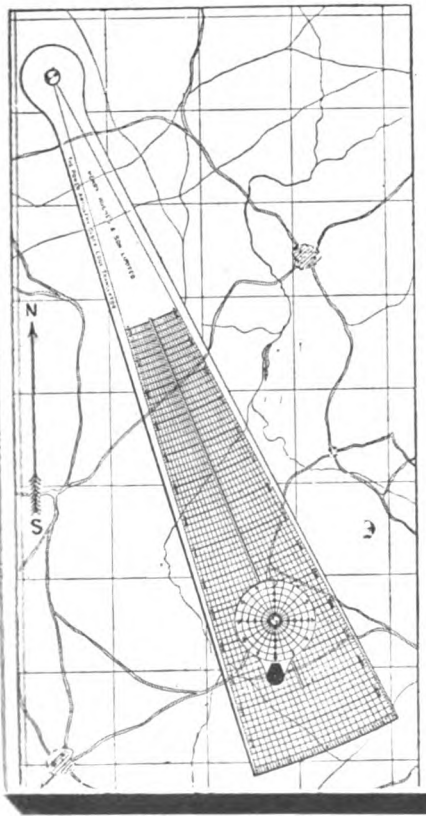

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SUMS IN THE FIELD.

BY MAJOR S. R. WASON, M.C., R.H.A.

THE GUNNER'S GUNNERY.

"The science of Gunnery like other inexact sciences is not for us all. Admitted that, other things being equal, the more gunnery a Battery Commander knows, the better he will shoot his battery; still it seems that if he has clear instructions from the expert, the Battery commander need not know the theory on which these instructions are based. The everlasting cry is "give me figures". It looks as if "Gunnery", spelt with a big "G", has a cousin "gunnery", spelt with a little "g", and this is what the regimental gunner officer of a national army wants to know. What proportion of Battery Commanders, at all events of Field Artillery, have ever seen a text book of Gunnery?

The regimental officer's education is based on the manual, Field Artillery Training; his technical training, in particular, on the drill books, handbooks and range tables of the guns he commands; add to these the courses of instruction which he attends. What gives him trouble, is not the theory, but the application of this theory in practice—often the method of application of this theory.

SUMS IN THE FIELD.

What sums must the battery commander be prepared to do? What is the minimum of calculation he must be able to compete with? What artificial aids can he carry about to assist him?

The range table is more and more becoming the standby of the battery commander in this respect; but up to the present it doesn't work out the angle of sight off a 1/20,000 map and it doesn't say anything about converting the aeroplane observer's signal into a correction to the battery.

If the war could be won by the multiplication of calculating protractors and such like we should be looking forward to next hunting season; if the average gunner could remember half the rough rules he is taught, hears of, or has recommended to him, the lightning calculation merchant at Barnum's might stay in America.

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A few of the sums.

1. To work out a magnetic bearing for a line of fire.
   (a). From a true bearing off a map.
   (b). From a measured bearing from an O.P. making allowance for displacement.
2. Solve TOB.
3. Work out displacement angle if the director is not placed in the line of guns.
4. Work out concentration or distribution if the aiming point chosen is not directly on the flank.
5. Work out angle of sight to target.
   (a). From a range and a contour difference.
   (b). When the angle of sight from O.P. to target and to battery are known.
6. Find concentration to "pin point" or distribution to cover a wide target.
7. If ranging on the line OT work out relation of deflection to elevation—the combined factor.
8. Find elevation and deflection factors.
9. Translate aeroplane's observations into corrections for the battery.

How can we do these sums?

Many of them can be done by the use of tables, most of them can be done by the use of rough rules, all of them can be done by the use of slide rules or other gadgets.

Tables are quick and accurate but the battery commander must learn to use them mechanically and must have some rough check over his results. Rough rules are quick, generally accurate enough but must be remembered word perfect and correctly applied: once forgotten they can rarely be deduced. Gadgets are quick, handy and the best of them do everything but talk, but the B.C. needs to be carefully taught how to use them.

All these methods have their merits and to persuade anyone who is accustomed to use any of them for any particular calculation to exchange it for something new would be ridiculous.

But sometimes the notebook with the tables in it is in the pocket of another coat, the rough rule has been forgotten or the gadget left behind in the stationery box: all these sums and many other small but necessary calculations can be made with the help of a page of a Field Message book, a pencil and the gunner's formula. Of this latter there are many forms; the B.C. in the field is dealing with degrees and hundreds of yards more often than with minutes and inches; "100^{x} at 2,000^{x} subtends 3° and at 3000^{x} subtends 2°" will do everything.

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A few examples:

It may be said that it is not necessary even to draw some of these but "right" and "left" are easily confused, especially when dealing with large angles.

Fig. I. is a case of 1. The line of fire is on a bearing of 175° off the map; the magnetic variation is taken 15°. The angle for the director is 170° left of N.

Where, as in the subsequent examples, diagrams are drawn to scale, the page of the message book may be regarded as a map of the ground round the target.

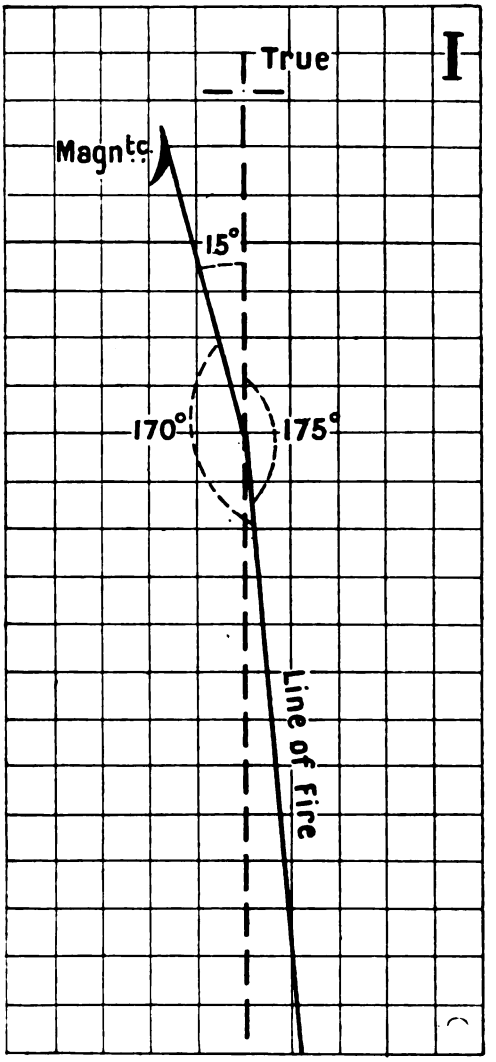

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Fig. II. The purpose in this case is to find the amount of deflection that must be given for every addition of 100ˣ in range to keep bursts on the line OT when the observing station is on a flank: this is a case of 7. This is especially necessary for making use of balloon observations if the balloon is not on the line battery target.

BT = 4200ˣ

BTO = 25°

O_1 B_1 (measured) = 46ˣ

100ˣ at 4000 subtends 90′

" 5000 " 70′

" 4200 " 86′

46ˣ " " 40′

for 1° M.R. add 150ˣ

Scale
10 divisions = 100ˣ

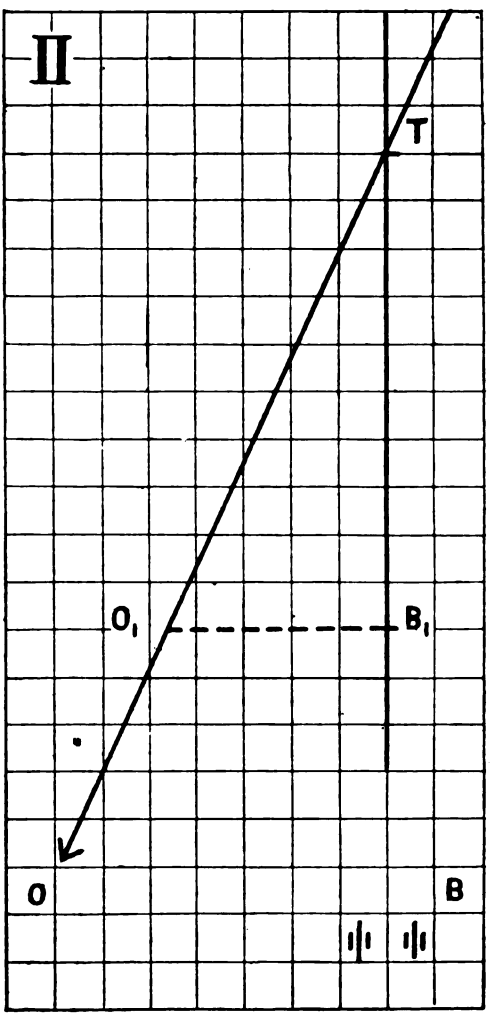

Fig. III. is a case of 8. To find the elevation factor, that is, the relation between the angle measured at O between two bursts fired on the same line and the distance in yards between those two bursts.

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III Same case II

$OT = 1200^{\text{x}}$
$O_{II}B_1 = 42^{\text{x}}$

100^{x} at 2000 subtends 180′
" 1000 " 360′
" 1500 " 240′
" 1200 " 280′
42^{x} " " 120′
100^{x} on BT subtends 120′ at O

or

$$\frac{E}{O} = \frac{100^{\text{x}}}{120'}$$

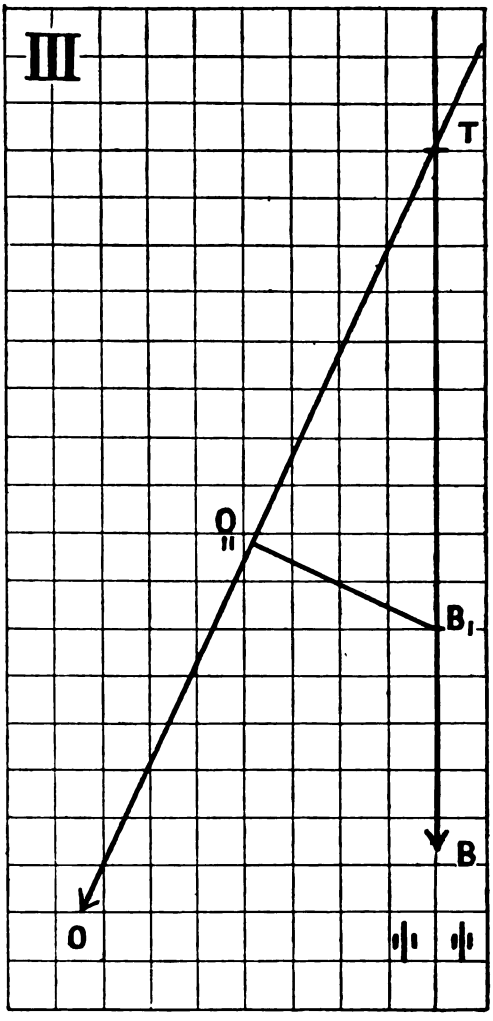

Fig. IV. is a method of plotting aeroplane observations which shows exactly where the shell falls: and the B.C. always has in front of him a picture of the pattern his gun is making round the target—especially if he keeps a diagram for each gun and records the fall of rounds on the corner of the diagram.

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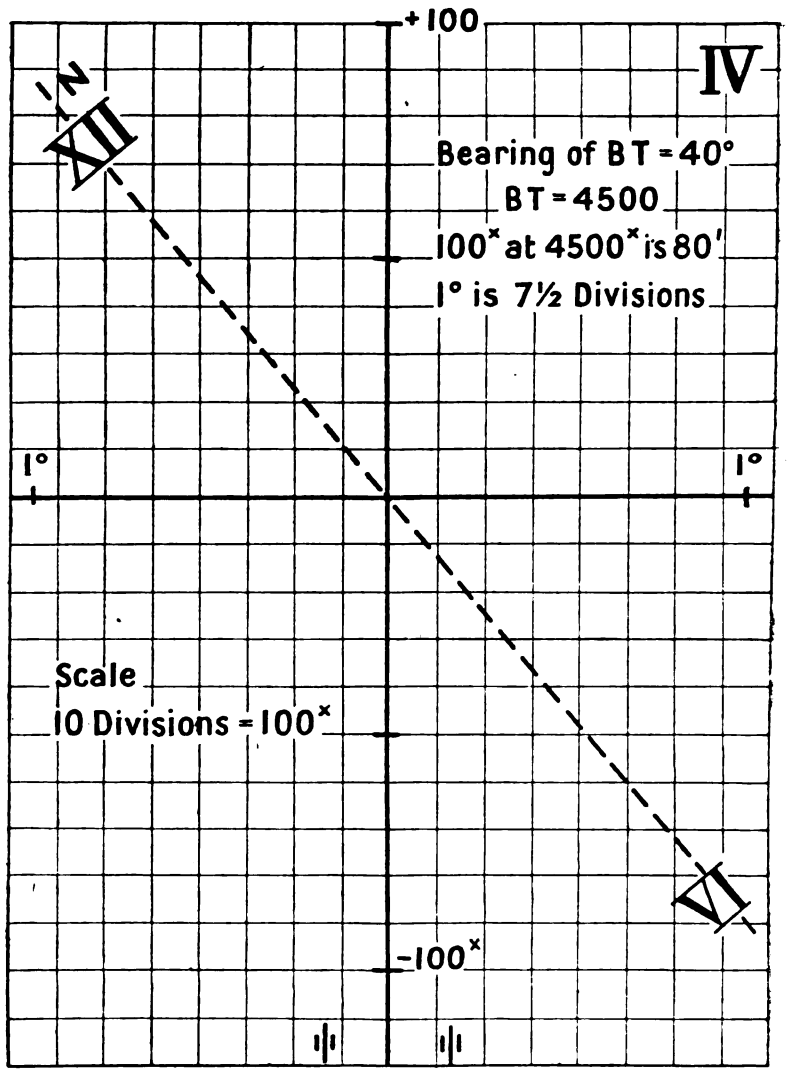

There are many other times when the same method will assist: a sufficiently accurate grid for using cross observations, by day or by night, is shown in Fig. V.

In many other cases the diagrams need not be drawn to scale.

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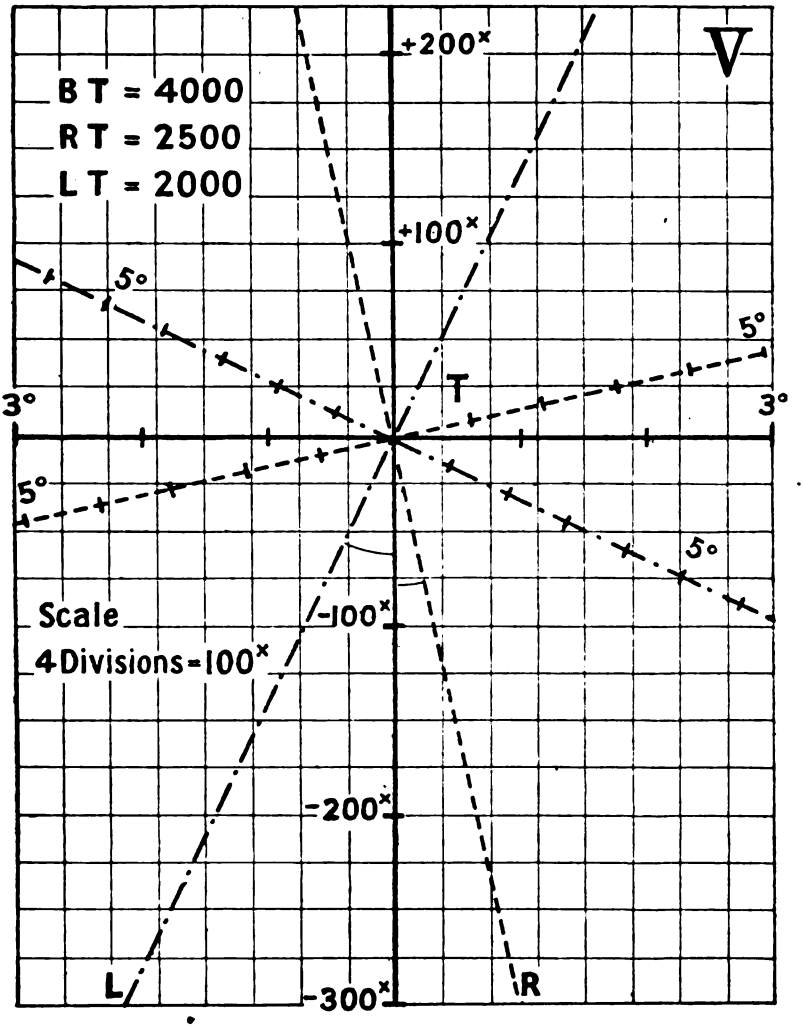

Fig. VI. shows how the direction of the wind may be considered when doing a difficult shoot on the line OT. It will be seen that unless the shell falls in the shaded area and therefore the smoke blows behind the target as seen from O, no definite use can be made of the round. If the smoke blew across in front of the target the round might be plus or minus, and might be right or left.

Briefly the suggestion is this: when time permits and accuracy is of importance, draw "the mental picture" to scale and the Field message book provides good squared paper ready for the purpose.

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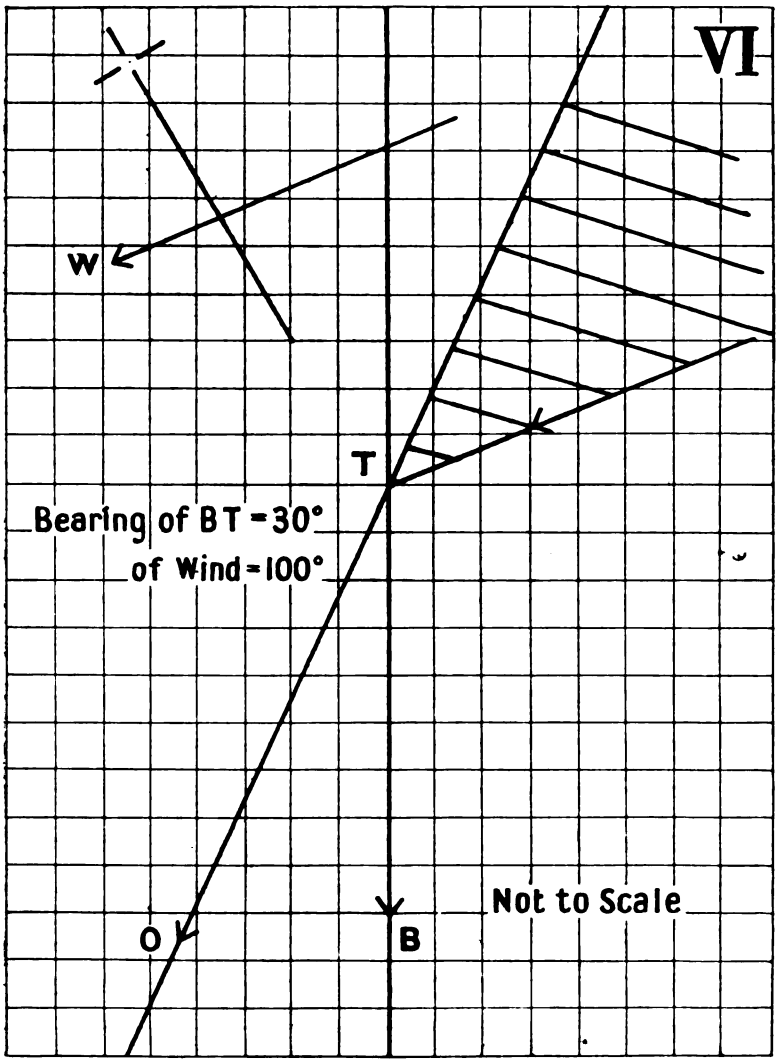

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OBLIQUE OBSERVATION.

BY MAJOR S. R. WASON, M.C., R.H.A.

FROM conversation with many Field Artillery battery and brigade commanders, and from the many letters, pamphlets and papers written, there still appears to be great variance of opinion on practical oblique observation.

As long as all officers are not taught the same thing in more or less the same way, so long will they invent different methods to suit themselves and so long will a certain proportion be slow to accept and practise anything that they have not been personally taught and taught to practise.

F.A.T. did not contemplate observation of fire from an O.P. some way off the line of fire and much nearer the target than the battery; consequently the very acute difficulties of oblique observation are not really discussed; but such observation is, and is likely to continue to be, the rule, and not the exception.

The difficulties are obvious and the means of overcoming them are several; but there is a suspicion that some of these have been evolved and perfected in an office, and even if this suspicion is unfounded, it has brought about a feeling of distrust, shared by many good regimental officers and some educational establishments.

The essence of the difficulty of observing from a flank is the difficulty of differentiating between the two things that may cause the target to be missed, errors in range and errors in line.

Taking visual observation from the ground as a whole, observation of three different natures is obtainable—

A. Observation from, or near, the line of fire.

B. Observation from a position at, or nearly at, right angles to the target on the line of fire.

C. Observation from any point between these two, which is here called oblique observation.

When A is concerned it is taught that the line can be accurately corrected, but that the range must be bracketed for: thus if the first round falls 3° left of the ranging point and the observing station is two-thirds of the way up the line of fire, the observer gives "1° M.R.", knowing that this will correct his line.

When B is concerned the reverse is the case; it is recognised that while the fall of a single round may not represent the M.P.I. of 100 rounds fired at that elevation, the M.P.I. of 4, 6 or 8 rounds will begin to approximate to that of 100; it may be said then, that with right angle observation the range can be accurately corrected but the line must certainly be bracketed for: there is no way of measuring what deflection must be given to correct the line.

In the case of C if both line and range are wrong, there is no conceivable way of measuring either error, hence no "correction" can be made: line and range must both be bracketed for.

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In all methods of observation and correction, whereas the 100% length zone is fully appreciated, the 100% breadth zone is considered to be negligible until fine corrections have to be made.

In the case of C, when the line has been found the range can be accurately corrected, or if the extra ammunition required is more valuable than the time involved by the necessity of dealing in factors, the range can be accurately found by bracketing.

From this it appears that in oblique observation the first object of the B.C. must always be to correct his line; as until the line is corrected he cannot say what range will be needed to put the M.P.I. of the gun on to the target.

In practice a B.C. can use any of three plans to differentiate errors in range from errors in line and to enable him to correct the latter; he can combine any two or even make use of all three at the same time. It must not be thought that any of these are in any way theoretical methods: on the other hand they have been evolved from the result of much shooting with oblique observation by B.C's. themselves.

The necessity for three methods is due to the varying difficulties of correcting the line; if the line can be corrected by an easy method involving neither factors nor recording nor the expenditure of much ammunition, it would be folly to adopt a more elaborate method which is necessarily more deliberate; the more elaborate methods are, however, absolutely necessitated by other targets.

The three methods are these:—

1. The method of visualizing the line of fire to get information as to the correctness of the line.

2. The method of making use of sectors to get information as to the correctness of the line.

3. Ranging on the line of observation to obtain rounds which alternately obscure the target and silhouet it, thus enabling the B.C. to bracket for line.

In each of these methods, an indication as to the line of fire is looked for: the B.C. alters the line to bracket the target and looks for further indications to reduce that bracket. Any of the three methods can be employed deliberately or in a quick shoot: the method to be employed is indicated not by the time available, but by the nature of the target and the difficulty likely to be experienced in correcting the line.

1. The first method necessitates no calculation, is quick and needs no recording; as soon as the line is seen to be to the left a deflection is given to the right and the target bracketed for range and line at the same time; this is the "shooting gallery" target method known to all; but one hint may be given, make no alterations for line until the line is undoubtedly wrong; all alterations of range without alterations of line help the B.C. towards correctly visualizing his line of fire.

2. The second method is the use of sectors to enable the B.C. to see if his line is to the right or left of the target, the most commonly used cases are those shown in the diagram; the essential for the use of this method is a definite line passing through the ranging

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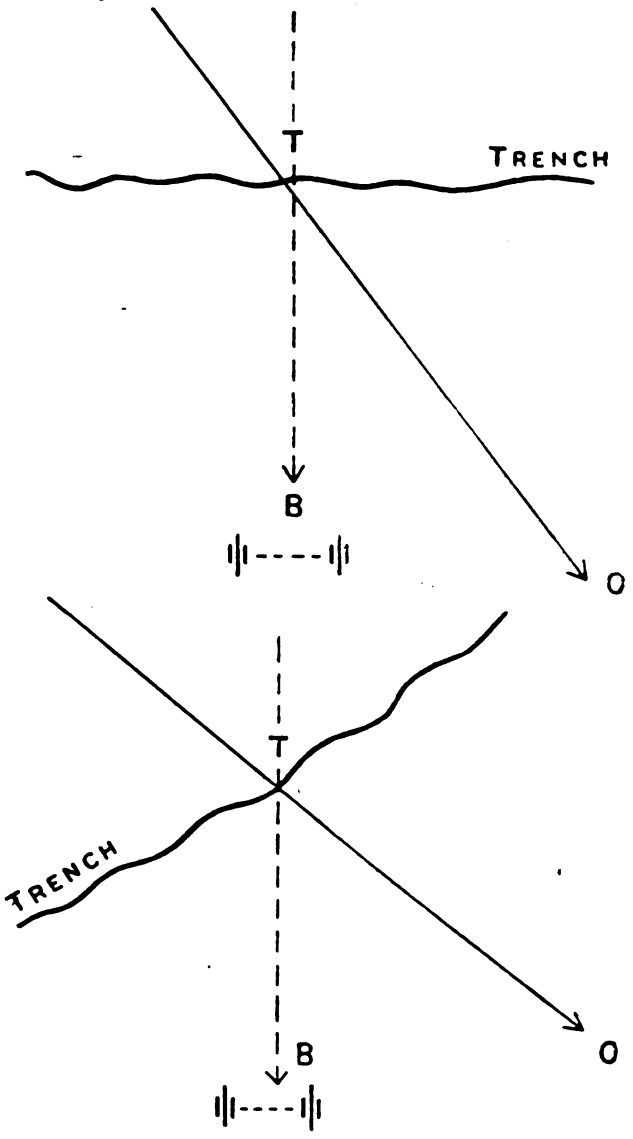
point. This line may be a trench, a fence, a road or a stream, it may even conceivably be imaginary, that is to say, if the target is a battery in action or a line of pill boxes the ground line of all the parts of the target connected up and produced gives the definite line necessary to provide the sectors. In practice it is not really necessary to know whether the line is at right angles to the line of fire or oblique to it, so long as the information obtained as regards range is not accepted as absolutely correct until the line has been finished with: this makes the method independent of the use of a map. The factors discussed in 3 can be made great use of but are not in any way necessary to success and merely help to save ammunition



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This method is very valuable in making use of observations from a balloon, if the battery is not on the line balloon target. If the officer in the balloon can actually shoot the battery, then he can use method 1, but if he is merely giving observations, his attempts at visualizing the line of fire will be frustrated by his not knowing what the battery is doing, or, as he is probably not a gunner, by his not understanding the significance of the orders given to the battery even if he gets them.

The alternative is for the balloon observer to give observations on the line balloon-target; if there is such a line through the target that sector ranging is possible, the shoot will be done in half the time and with half the ammunition.

3. The third method is only turned to as a last resort in case the range and line to the target cannot be otherwise obtained. It entails the use of a factor or factors which can be found accurately, or more or less accurately in many different ways: but here it is to be noticed that the combined factor is the only one which is essential and that this can be guessed at and the B.C's idea revised if he finds it wrong: in open warfare or shooting without a map the apex angle can be found by the difference between the bearings of the target from the O.P. and of the line of fire from the battery.

All ranging on the line of observation entails two processes: firstly, a round must be got on the line O.T. and secondly, subsequent rounds must be kept on, or as near the line O.T. as possible by the use of the combined factor. The process of getting a burst on the line O.T. can be carried out by bracketing or by the use of the elevation or deflection factors if ammunition is valuable.

The one thing that the B.C. must be certain of before he starts, is that his whole reason for going in for this slightly complicated system is that he suspects his line may be wrong and that he wishes to correct it; as he cannot measure the error he must bracket the target for line and reduce this bracket, the necessary alterations in range being merely to keep the bursts on the line of observation and not in any way to bracket the target for range.

To sum up:—Method 1, that of visualizing the line of fire is, and always will be, the standby of Field Artillery, but certainly cannot be applied to all targets. Where heavy natures of guns are concerned and ammunition is likely to be of more value than time and consequently when it is necessary to get all possible value out of every round a combination of every method that can assist is indicated. Method 2, that of sector ranging is a special one, by which if the necessary conditions are present, difficult targets can be automatically ranged on quickly and cheaply and without preparation.

Method 3 entails the use of factors and generally speaking, of time to prepare them, of a certain ammunition expenditure and of a system of recording the shoot; but by this means the most difficult target can be registered so long as a certain proportion of the bursts can be seen and so long as safety considerations cannot interfere. If time and ammunition are available and communications are satisfactory, accurate results can be guaranteed.

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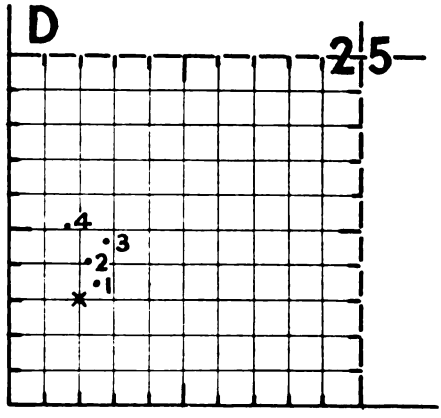
NOTES ON THE USE OF MAJOR SWAYNE'S SHEETS.

By Major C. E. Hare, M.C., R.G.A.

Position of No. 1 (pivot) gun D25C 25·35



Assume the target record diagram is being used in $\frac{1}{20000}$ scale. In the "Instructions for use" it is suggested:—

(1). "If the gun position is known to a greater degree of accuracy than the nearest 50^{x} (or 25^{x} on $\frac{1}{10,000}$ scale), assume the gun position is at the nearest corner of a 50^{x} square (i.e. at **X**). The range error cannot be greater than 35^{x} (or 18^{x} if $\frac{1}{10,000}$ scale is used), and a correction can be made to all ranges read from the diagram to allow for this."

This entails two corrections to be applied for each Target. Normally 2, 3 and 4 guns will have "Range Correction and Concentration Tables" made out with reference to pivot gun, and then there will be the further correction for the distance of pivot gun from point **X**.

I suggest that a "Range Correction and Concentration" Table be made out for *all guns with reference to point* **X**, in the usual manner for zero line and every 10° R and L of zero.

This was originally suggested to me by my B.C.A. 347498 Br. F. Hamilton on first using the sheets.

(2). "Mark ray nearest to target 50° (representing 50° R from A.P.) or 0° (representing zero line).

Diagram reading of target is	50° 10′
To hit target you set at	50° 20′

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Therefore correction to apply to diagram reading is 10′ R.

Thus if target fall on ray 1° 15′ L

Switch angle is 1° 05′ L "

I suggest that it would be simpler to apply the correction to the zero angles of the guns than to the diagram reading. To take an example:—Zero line of the guns is 60° grid. Mark this ray on the sheet 0° and the others R and L from it. (A.A.P. angle for No. 1 for zero line is 110° L).

Say diagram reading of target you register on is 40′ R

Switch given to guns is 40′ R

No. 1 gun's angle to AAP is 109° 20′ L

after firing, (allowing for wind, etc.) it is found that No. 1 gun requires 20′ M.R.

The zero angle for No. 1 becomes 109° 40′ L, and the switch for any target can be read direct from the sheet.

In the same way the other guns, if laid parallel, would have their zero angles altered by 20′ M.R.

These are small points, but if the suggestions in (1) and (2) are followed, switches and ranges can be taken direct from the diagrams without any line or range corrections having to be applied, except from the usual Table which is made out for every battery position.

The paragraphs in inverted commas are not word for word quotations, but are nearly so, and I do not think the meaning has been altered.

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SIMPLEST FORM OF FIELD PLOTTER FOR QUICK WORK IN THE FIELD.

(Position on Map being unknown.)

BY BT.-COL. A. ff. POWELL, D.S.O., R.G.A.

1. Is simply a circle of convenient radius, say 4", graduated from 0 to 360° and a ruler or tape with scale ½ inch to 1000ˣ showing hundreds of yards.

2. The pivot Gun of the Battery is always assumed to be at the centre of the circle.

3. A practical example will best show its use:—

Ex. A B.C. carrying such a graduated circle (pasted or pinned on to a piece of card board) and ruler or tape is ordered when on the march to come into action against a hostile formation somewhere N.E. of his position at the moment.

Action taken by the B.C. (Case I.).

The B.C. orders his Battery to come into action in the nearest suitable position and gives his Battery Leader instructions to get the Pivot Gun pointing N.E. and the remainder on parallel lines to it and to put out a sub base of 20 yards (60 feet).

The B.C. therefore leaves his Battery with the knowledge that when he arrives at his O.P. his Pivot Gun at B is pointing as in Diagram.

Having found a point O where he can see both the Target and the Pivot Gun, he takes the bearing of the latter and finds it to be 155°. His bearing from B is therefore 335° and he now lays out his ruler from B to the 335th degree on the circle and draws a line.

His position is somewhere on this line. He now takes the angle subtending the sub base and finds it to be 1° 30′.

Therefore the distance O.B. is $\frac{72000}{90} = 800^{x}$. (The figure 72000 is a constant as long as a base of 60 ft. is used. For explanation see below). Note 3.

The position of O with regard to the Battery is now fixed.

Meanwhile his B.C.A. has taken the angle T.O.B. and he draws the line O.T. punctuating the 1000ˣ on it as in Diagram.

Assuming the B.C. has to estimate the range of the Target his best course is to put it within certain limits and then take the mean, for instance if he can say that it is over 2000ˣ and not more than 6000ˣ he will assume that it is 4000 yards.

He is now in a position by means of his tape or ruler to give the switch from N.E. to the assumed position of his Target (at 4000ˣ along the line O.T.) and the range. See Diagram.

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*If the Guns have the right correction for the day his rounds should fall about the assumed position of his Target.

They would probably fall near enough to the line to inform him if he was — or + of his Target. Assuming that he was - he then takes the 5000[x] mark on his line O.T. again measures the switch to it from the last one given and measures the range and so brackets his Target, using the graduated ruler or tape to give him his switch and range till he is on his Target.

Two minutes is ample time for him assisted by his B.C.A. to perform the simple operations necessary before sending down the switch and Elevation to his Battery.

The Switch to any fresh Target and its known or assumed Range can be given immediately the new T.O.B. angle is drawn.

Case II.

Should the B.C. be unable to find a position handy from which he can see both the Target and the Pivot Gun. The Reconnaisance Officer intervenes and having found a position from which he can see both the B.C. at O. and the Pivot Gun, sends the B.C. the bearing of his (the R.O's) Position from B, and his distance from it and the angle B.R.O. He then puts out a sub base of 60 feet.

The B.C. is now able to Plot the position of the R.O. with regard to B (the Pivot Gun) and lays off the angle B.R.O.

The B.C's position is on the line R.O. and the sub base put out by the R.O. enables him to fix it. He now joins O.B. and proceeds as in Case 1.

Notes.

1. It is not necessary to draw any lines the points only need be marked.

2. In calculating O.B. taking 5% of the result off makes it more mathematically correct, i.e., to say in the instance above 760 should be measured instead of 800.

3. The figures $\frac{72000}{90}$ is $\frac{120 \times 600}{90}$ and is deduced from the fact that an angle of 2° (120 minutes) gives a base in feet equal to the $\frac{\text{range in yards}}{10}$ and consequently 2° with a base of 60 feet will give a range of 600 yards and any other angle X with the same base will give $\frac{120}{X}$ of 600 yards, or $\frac{72000}{X}$ yards. X being the angle in minutes subtended by the sub base.

4. The compasses of the B.C. and Battery Leader should be synchronised.

5. It is an advantage to have the circle on lightly squared paper sides of the squares on the same scale as the ruler or tape.

6. Magnetic North serves the purpose as well as true. N.

*7. If through the various causes that may happen the 1st rounds do not fall on the line OT the Observer must bring them on then putting the actual Range the guns are firing at into Map Range he knows by means of his graduated ruler at what point on his line OT they are falling and therefore the Switch and Range to any other point on his line he wishes to get them to.

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CORRECTION TO RANGE WHEN FIRING WITH ANGLE OF SIGHT.

By 2nd Lieut. F. G. Soper, R.G.A.

WHILE working on the formula in the article on this subject that appeared in the January issue of the Journal namely

$$\text{Sin } (2\phi' \pm s) = \sin 2\phi \cos^2 s \pm \sin s \quad \ldots\ldots(1)$$

the following formula was derived:—

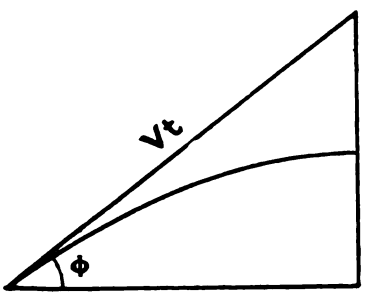
Increase to Range required to hit Target leaving the angle of sight on the guns in the usual manner

$$= H \tan \phi \quad \ldots\ldots(2)$$

where H = the difference in height in yards between the target and battery and ϕ = the elevation that would hit the target on the horizontal plane.

In the formula (1) the quadrant angles have been compared that give the same range on the horizontal plane and also on a slope of s°. By working from a slightly different standpoint and comparing the ranges on the horizontal plane and on the slope of s° obtained with the same tangent elevation a much more workable formula is obtained and one much more easily remembered. There is a slight approximation in it, but it makes such a small difference with the ordinary angles of sight that it can be neglected.

It is derived either by considering the equations of motion that govern a body projected in the air, using Siacci's formulæ or by the simpler method of considering the parabolic motions of a body projected in vacuo. The latter is rather more easy to understand and gives the same result on assuming that the effect of the air in the two cases (on the horizontal plane and on the slope) is the same. This is not strictly true as the trajectory on the slope is higher and consequently the resistance of the air to the projectile at its highest point is less than in the other case. The effect though for angles of sight under 10 or 15° is negligable. Working on this method and considering the range R of a projectile fired at an angle ϕ° elevation the distance the shell travels horizontally in t secs = the horizontal component of the initial velocity $V \times t = V \cos \phi . t$.



The vertical distance it travels = $V \sin \phi . t$

– the distance the shell drops in t secs

$= V \sin \phi . t - \frac{1}{2} g t^2$.

where g is the acceleration due to gavity.

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When this distance is zero

i.e. when $V \sin \phi . t - \frac{1}{2} g t^2 = O$

$t = O$ or $\frac{2V \sin \phi}{g}$

i.e. the time the shell takes before reaching the ground is $\frac{2V \sin \phi}{g}$

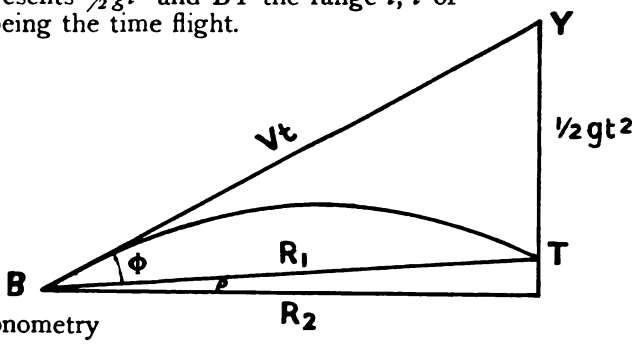
$\therefore$ The distance the shell travels is its horizontal velocity $\times \frac{2V \sin \phi}{g} = \frac{2V \sin \phi}{g} \times V \cos \phi = \frac{2V^2}{g} \sin \phi \cos \phi$

In other words the range on the horizontal plane obtained with an angle of elevation $\phi^\circ = \frac{2V^2}{g} \sin \phi \cos \phi$ .....(3)

On an inclined plane or slope of s° let the range be R_1 and the tangent elevation be still ϕ°. This is what happens in the normal course when laying the gun.

The muzzle velocity remains the same = V.

In the Δ BYT in the figure, BY represents Vt, YT represents $\frac{1}{2} g t^2$ and BT the range t, t of course being the time flight.



By trigonometry

$$\frac{YT}{\sin YBT} = \frac{BY}{\sin BTY} = \frac{BT}{\sin BYT}$$

i.e. is $\frac{\frac{1}{2} g t^2}{\sin \phi} = \frac{Vt}{\sin (90^\circ + s^\circ)} = \frac{R_1}{\sin (90^\circ - (s + \phi))}$

i.e. is $\frac{\frac{1}{2} g t^2}{\sin \phi} = \frac{Vt}{\cos s} = \frac{R_1}{\cos (\phi + s)}$ $\left(\text{from } \frac{\frac{1}{2} g t^2}{\sin \phi} = \frac{Vt}{\cos s} \right)$

$t = O$ or $\frac{2V \sin \phi}{g \cos s}$

Now $\frac{R_1}{\cos (\phi + s)} = \frac{Vt}{\cos s}$

$= \frac{2V^2 \sin \phi}{g \cos^2 s}$

(substituting for t)

i.e. $R_1 = \frac{2V^2 \sin \phi \cos (\phi + s)}{g \cos^2 s}$ .....(4)

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Let the horizontal distance between B and T be R_2

$$R_1 = R_2/\cos s$$

$$\frac{R_2}{\cos s} = \frac{2V^2 \sin \phi \cos (\phi + s)}{g \cos^2 s}$$

$$R_2 = \frac{2V^2}{g} \cdot \frac{\sin \phi \cos (\phi + s)}{\cos s}$$

As will be seen R_2 is the range BT as measured on a map and the ratio of the ranges of projectiles fired on a horizontal plane and on a slope of s° will be given by the ratio $R : R_2$

$$= \frac{2V^2}{g} \cdot \sin \phi \cos \phi : \frac{2V^2}{g} \frac{\sin \phi \cos (\phi + s)}{\cos s}$$

$$= \cos \phi : \frac{\cos (\phi + s)}{\cos s}$$

$$\text{i.e. } R/R_2 = \frac{\cos \phi \cos s}{\cos (\phi + s)}$$

$$\frac{R_2}{R} = \frac{\cos (\phi + s)}{\cos \phi \cos s}$$

$$= \frac{\cos \phi \cos s - \sin \phi \sin s}{\cos \phi \cos s}$$

$$= 1 - \tan \phi \tan s.$$

$\therefore R_2 = R - R \tan \phi \tan s$

but R tan s = the vertical distance between the battery and target approximately

= H (in yards)

$\therefore$ the distance the shell pitches short of the target

= H tan ϕ yards

Now H tan ϕ is rarely greater than 400 and so if we increase the range by H tan ϕ the effect of the non rigidity of the trajectory is inappreciable and the shell should hit the target.

To extend this to the motions of the projectile in the air one has only to remember that the effect of the air in resisting the motions in the two cases under consideration will be the same for ordinary angles of sight and therefore the same increase in Range is necessary.

It will be noticed that the angle of sight is put on in the usual manner and the range increased or decreased by H tan ϕ yards according as the angle of sight is positive or negative. If the angle of sight is positive add to the range, if negative subtract.

This has the same effect as the corrections in the January article in keeping the range constant and altering the angle of sight.

Perhaps one or two examples will illustrate the method of working and the necessity for correcting in certain cases.

HB in guns ϕ is small so that H tan ϕ is nearly always negligable. The following examples are taken from a 6″ 26 cwt. Range Table.

CHARGE iii.

1.	Range to Target from map	= 5000
	Angle of Sight	= + 2°
	By the Range Table ϕ	= 16° 25′
	and 3′ Elevation	= 19

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H tan ϕ = 50^{x}

$\therefore$ Correction = + 12½′
(Correction tables 11′)
in Journal.

CHARGE iii.

2. Range BT = 7000 $\therefore$ ϕ = 27° 14′ and 5′ = 12^{x}
A of S = −3°
H tan ϕ = −188^{x}
= − 1° 15′
(Table 1° 2′)

The above examples are perhaps a little exaggerated with respect to their Angle of Sight but with even an angle of sight of 30′ the effect is worth taking into consideration.

CHARGE iii.

Range BT = 7000 $\therefore$ ϕ = 27° 14′ and 5′ = 12^{x}
A of S = + 20′
H tan ϕ = 31^{x}
= 10′

The distance in this case is 31^{x} which might make some effect.

In the case of certain Howitzers, where the elevation is greater than 45° a slight modification of the formula is required. If the elevation when firing on the horizontal plane be ϕ'

$$\text{Range} = \frac{2V^2}{g} \sin \phi' \cos \phi'$$

If firing with the same Q.E. i.e. ϕ' at a target of angle of sight $+s$°
T.E. = $\phi' - s$

Substituting this value in (1)

$$R_1 = \frac{2V^2}{g} \frac{\sin (\phi' - s) \cos \phi'}{\cos^2 s}$$

$$\text{and } R_2 = \frac{2V^2}{g} \frac{\sin (\phi' - s) \cos \phi'}{\cos s}$$

$$R_2/R = \frac{\sin (\phi' - s) \cos \phi'}{\cos s} \Big/ \sin \phi' \cos \phi'$$

$$= \frac{\sin (\phi' - s)}{\cos s \sin \phi'}$$

$$= 1 - \cot \phi' \tan s$$

$$R_2 = R - R \tan s \cot \phi'$$

$\therefore$ Distance the shell falls short

= H cot ϕ' approx.

$$= H \tan \left(\frac{\pi}{2} - \phi'\right)$$

Thus in this case the Angle of Sight is not included in the elevation and the correction in yards required.

is H tan (90° − Elevation due to map range)

The same rule applies to whether the correction is plus or minus as in the case of angles of elevation under 45°.

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ORDNANCE ON THE ALLIED FRONT.*

Developments in Artillery During the War.

By Major-General J. E. W. Headlam, C.B., D.S.O.
in Charge of the British Artillery Mission to America.

IF I can not claim to be one of those artillerymen who have invaded the domains of science, I have learned, as an artillery commander in the field, how much we owe to the scientists who have devoted their talents to the solution of the problems which confront us. I think therefore that I may be able to tell you something of the development of artillery during this war, from the user's point of view, which may be of interest. The subject is so vast that it would be quite impossible even to touch on, much less to deal adequately with all the directions in which these developments have taken place, even if I were to devote myself entirely to the science of artillery.

But this is not everything. To engage the right target from the right place, with the right guns, this is the artilleryman's *art*, without which his *science* is half wasted. In artillery, more than in any arm of the service, tactical and technical considerations are most intimately connected. I shall try to show how the changes in tactics affect technical matters and how the demands of the soldier may upset the plans of the scientist and I hope that I shall be able to make you understand that the entry of science into war has in no way taken away the glamour of romance, however it may have increased its horror.

I shall not trouble you with any reference to organization. You must accept it from me that every operation in this war has confirmed the necessity for a carefully elaborated scheme for the employment of concentrations of artillery, involving a methodical allotment of tasks from the outset, and largely depending for its successful execution on an effective chain of artillery command.

Field Artillery Material.

It will, I think, be advisable to commence with some brief reference to the various types of artillery employed in the field, without attempting to go into detail regarding any particular nature. Taking field artillery first, we stand practically where we were. At one time an idea got abroad that the days of field artillery were numbered, that it had been supplanted by the "heavies." This was a very dangerous heresy, but it is dead. The field artillery is as firmly established in its position as it ever was, the proportion of guns to bayonets has altered little, and the material has changed least of all. The Germans still have their old field gun, made as a breech loader in 1896 and converted into a quick firer in 1906. Our own 18-pounder, which was brought into the service at the beginning of this century, immediately after the South African War, is still

*A lecture given before the Washington Academy of Sciences on April 3rd, 1918. From the *Journal of the Washington Academy of Sciences*.

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in our belief admirably suited for its work. It is no secret that the American artillery has adopted a field gun designed and made by those admirable gunners, the French, in the nineties of the last century.

Shrapnel Versus High Explosive.

But there are two points in connection with field artillery material on which a real difference in opinion and practice exists.

The first is the relative values of shrapnel and high explosive shell. On this the French and ourselves are the great protagonists of the rival schools. Their 75-mm. is primarily designed for the rapid fire of high explosive shell and its "rafales" did marvels in throwing back the first great German advance on the Marne. The English, as befits the country of the inventor, General Shrapnel of the British Army, have always been great shrapnel adherents; our 18-pounder was designed as a shrapnel gun, and has undoubtedly the most powerful shrapnel in existence. I admit that we carried this too far in having no high explosive at all, and you may possibly recall the great outburst of indignation caused by some so-called "revelations" in the press regarding the shortage of high explosive shell in 1915. The question now is not of there being enough high explosive, but of getting the artillery to use the proportion that the manufacturers would like to produce. We saw the effect of our shrapnel on the German infantry in 1914, and we have not forgotten it.

The second is the advisability of including howitzers in the field artillery. Here again we join issue with our French friends, who hold that the lowest calibre for the howitzer is the 6-inch. But we know what our howitzers have done for us, and as I see again in memory the many fields on which our 4·5-inch rendered such yeoman service, ever since they first came into action among the slag banks and pitheads at Mons, I can scarcely imagine how we should have fared without them. And here I know that our infantry would back me up.

Use of Heavy Artillery in the Field.

When we turn to heavy artillery, in which I include all natures other than field, the story is one of almost miraculous progress. Broadly speaking, it may be said that heavy artillery formed no part of the equipment of modern armies at the commencement of the war. This is not strictly true, for the Germans had a battalion of 6-inch howitzers in each corps, while we had a battery of 60-pounders in each division. But the use of heavy artillery in the field was no new thing, though the whole world gasped in amazement when the Germans brought up their big siege pieces on the Aisne. In modern days it had been done with success by the Boers, who used the 6-inch guns taken from the fortifications of Pretoria with success against us on many occasions. As soon as Port Arthur fell, the Japanese brought their 11-inch howitzers to join the field army in Manchuria, and the mountings of some of your coast defence guns on their way to join the field army in France are modelled on those which our sailors improvised to carry their ship guns across the South African veldt.

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Proportion of Howitzers.

In field artillery we have seen that controversy raged around the inclusion or not of howitzers at all. In heavy artillery all are agreed that both are necessary, but opinion is at variance as to the proportions of each. Here again we find ourselves on the side of the Germans while the French are, or were, all for the gun. But in this matter as in so many others, friendly discussion, and the exchange of experience, has brought us very much to the same point of view. The whole thing really turns on whether howitzers should be used for counter battery work or confined to bombardment. We hold that the howitzer is more accurate against such a target as an enemy's battery; that it is more mobile for the same weight of shell; that its fire can be more easily observed, especially from an aeroplane; that it has a longer life; and that it is easier to place, not only because it can be tucked away into hollows of the ground where it would be impossible to use a gun; but also (and this is a curious development of this war of masses), because it can be used in crowded areas. I have often seen our big howitzers in action in the midst of a mass of congested traffic around some depot of supplies, with troops moving in every direction, wagons loading up with stores, and so forth, under their very muzzles, where the blast of a gun would have swept everything away in front of it. But while controversialists are marshalling such arguments it looks as if the ground would be cut away from under their feet by the disappearance of the distinction between gun and howitzer. The length of the howitzers has gradually grown from 13 calibres to 17, and now in some of the latest to over 20, while the use of varying charges either to reduce the wear, to or allow of the employment of curved fire, is gaining ground for guns.

Trench Mortars.

At the other end of the scale we have trench mortars again only a revival of a weapon well known a century or more ago. They also were used extensively by the Japanese in Manchuria, but I am afraid that the artillery as a whole was rather inclined to scoff at them when they first appeared. Those days, however, soon passed. It was recognized that in the form of trench mortars, we could increase our strength for bombardment by utilizing *material and labor not good enough for guns*. The German trench mortars, for instance, were chiefly made by a firm famous the world over for its cream separators. What distinguished officers at one time called "tin pot artillery" thus rose gradually in favor, until in Italy it took the place of horse artillery as a *corps d'élite*. But in those days we were shorter of guns and ammunition than of men. Now the position is reversed. Trench mortars are terribly expensive in men, and more especially in officers, and so just when the material is being perfected, the mortars are dropping to some extent out of use. It is just one of those changes which must be so baffling to the civilian who tries to help us.

Increase in Range.

With all natures, guns and howitzers, field, heavy, and trench mortars, there has been a continual cry for range, and still greater range. This has been due to many causes, chiefly tactical, but

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principally to the extension of field of fire given by aeroplane observation. The various expedients which have been resorted to to meet this demand are interesting. In the first place there was the simple lengthening of the howitzers, and the bringing into the field of the long high-velocity naval and coast-defence guns. Then there came the various alterations in form of shell, the general feature of all of which is a great lengthening of the ogive (the pointed nose of the projectile). The radius of curvature of the ogive has been increased from 2 to 6, and in some cases to 8 calibres, but the most notable form is the French "Obus D," so called after General Desailleux, the officer chiefly responsible for the design, and usually designated by us as the "streamline" form. Our experience with this form has not been very encouraging, but it is admitted that the slope of the base has a very important bearing, and must be determined for each nature, and I may mention as an instance of the close co-operation existing between us, that the French have recently designed a shell for trial in our guns with which we hope to get better results. The "false head," another form of the same idea, is largely used by French and Germans in the heavier long range guns, but again it is not so popular with us. It introduces considerable complication in supply and fitting and is suspected of being a possible cause of "prematures." No doubt with the extension of the use of longer headed shell, the necessity for false heads disappears to a great extent. But I am by no means satisfied that they have not great possibilities when used with shell designed from the commencement for them.

Long-Burning Fuses.

The most difficult problem in connection with range is the provision of a time fuse which will be reliable for long range fire. We should use shrapnel far more than we do, if we could get a good time fuse, reliable at long ranges. Here is an opportunity if ever there was one for the scientists. As you probably know, the fuses in the service now depend on the burning of a train of composition, which is liable to many inaccuracies, especially when you consider the conditions under which it has to be kept on service. Mechanical fuses have been known for long, and we did our best to encourage inventors nearly twenty years ago, but such fuses only came into real use last year when it was noticed that the Germans were making uncommonly accurate practice at our balloons, at ranges up to over 20,000 yards. Early in the summer we got specimens of their fuse, which turned out to be a clock-work fuse designed in 1916. The Academy of Sciences will be interested to hear that they were at once handed over to the Cambridge Physical Laboratory—it would perhaps be indiscreet to proceed further with my revelations.

Use of Guns at Close Quarters.

But if the tendency is always to increase the range of our guns, do not think it is with the object of keeping them back. Far from it, for even if guns are as a rule further apart than they were in the old wars, the men who direct the guns are closer than they were even in Napoleon's time, and there is still as much room as ever for the display of personal enterprise and gallantry. But as a matter of fact, just as this war has seen the revival of hand-to-hand fighting

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with the bayonet and the butt, so it has seen guns pushed into closer ranges than has occurred for a century at least. On many occasions I have known individual field guns put within 200 yards of the enemy's trenches. This was of course for some special task, such as breaching a parapet or knocking out some particularly obnoxious "nest" of machine guns. With time, ingenuity, and courage, a gun can be got almost anywhere, and the effect of its fire at such ranges is very marked, while its presence affords immense encouragement to the infantry. Great care must of course be taken in working out the preliminary arrangement, and in one case I may mention where a gun had to be brought up over the open, it was moved at night under a canopy, like a dignitary of the Church in high festivals, and the gunners who carried the canopy were trained to drop it on the gun whenever a flame went up. This gun fired its 100 rounds at a range of 70 yards in nine minutes, completely destroying its objective, and the detachment then, strictly against orders, joined in the assault.

Another case I know forms rather a touching story. When I was on the Italian front beyond Gorizia in 1916 I happened one day to see a gun very cleverly concealed in the front line, to be used in much the same way. Curiously enough I met last year the commander of the corps to which this gun belonged, and talking one day he asked me if I remembered it. He said he had been going around after me, and the noncommissioned officer in charge had told him how an English general had shaken his hand and congratulated him on being in the place of honor. Poor fellow, he did his work with complete success next day, but he and all his men were killed.

Increase of Heavy Artillery.

But, gentlemen, I am not sure that the real romance of artillery in this war does not lie in the efforts made to furnish us with the material we so urgently needed. At the beginning, as I have said, we had one battery of "heavies" per division, or 24 guns in the whole of our "contemptible little army." On the Aisne we got our first siege howitzers of 6-inch calibre, and I had placed under my command there the same battery which as a young staff officer I had guided to its first position against the Boers at Pardeberg. During the winter of 1914, a few more heavy guns and howitzers began to arrive, but by midsummer of 1915, we had only about 70 all told. The summer of 1916, however, saw this number increased just tenfold, while by last summer it had been more than doubled again. How was this done? In the first place by utilizing every gun, whether designed for a fort or a ship, that we could lay hands on. The mounting of such guns, for work in the field, either on railway trucks or carriages, has given great scope for ingenuity, especially as the task has become more and more complicated by the necessity for economy in metals and in skilled labor. But all along the great consideration has been *time*, and this of course has been especially true of new manufacture. It is to that element of time that I would like to draw your special attention, because it is one which, if you will pardon me for saying so, the scientist is perhaps a little inclined to overlook. It is only natural that he should be absorbed in the perfecting of his design, but the poor soldier facing the German can not wait for the fairy tales of science and the long results of time, but wants something, anything, and quickly, that will shoot.

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National Efforts.

And then Mr. Lloyd George, like a new Peter the Hermit, led a crusade to stir up the people at large to the manufacture of guns and shells. We perpetuated designs which we knew to be out of date. We adopted, with our eyes open, new designs which were in many points based on considerations of facility of manufacture, rather than of perfection, and we risked the omission of many of the regular stages of trial hitherto considered essential. It was a gamble, but it was the only way to get the numbers required, and it was justified by success. In this connection I may perhaps mention a most remarkable instance of adherence to antiquated pattern, in order to avoid any delay to output, afforded by the Germans. The outbreak of war found Germany, as I have already mentioned, with an obsolescent field gun, but as I personally discovered in the battle of the Somme, she directed all her energies, not to remedying its defects, but to developing production. I happened by accident to examine there two captured guns which were standing side by side. One, No. 40, had been made 20 years before and converted from breech loading to quick firing; the other, No. 6173, had only been made the previous year, but there was not a rivet's difference between them; only, in the new gun, time had been saved by omitting engraving the Imperial cipher on the breech.

Ammunition.

As with guns, so with ammunition, but perhaps, to a still greater extent, production has been the great problem, for from early in the first autumn of the war our stocks of ammunition were practically exhausted, and we gunners had over and over to turn a deaf ear to the calls for help from our almost exhausted infantry. Everything possible was done to expedite output. National shell factories were set up all over the country, for the smallest shop could at least make 18-pounder shrapnel bodies, and delicate women toiled long hours at the lathes. We adopted designs which were not the best but which were the easiest to make, and then faced the danger of "prematures."

The bursting of guns by the premature explosion of the shells is almost inevitable when one has to depend on hurried and unskilled production: it is one of the risks which must be run when shells have to be rushed out to the front. But the loss of guns and men may be serious, and it is always a trying ordeal to the artillery. The French with their large expenditure of high explosive shell were the first to suffer severely from it. I remember seeing many of their wrecked 75's when we were fighting side by side at Ypres at the time of the first gas attack, but they bore it with the calm fortitude which has been their attitude through all these long years of trial, and when our own time came, their experts placed all their experience at our disposal, and rendered us invaluable assistance in getting through our trials, and I would like especially to mention here the names of General Gossot, an artilleryman who has gained more than a national reputation as a contributor to science, and General St. Claire Deville, whose name is a household world in France as "the father of the seventy-five." It will do no harm now, and may do good, to tell you how serious our position was at

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one time. [The ratio of prematures, at first irregular, then rapidly decreasing, was shown by tables.]

There will always be prematures, and loss of life from them, while high explosive shells are used, but we look to science to apply its methods to the investigation of every case, and to guard us, as far as human ingenuity can, against them.

But what did we gain by accepting these risks? The average number of tons of ammunition fired away per week in France will probably be the simplest way of putting it. [The figures, in tons per week, showed the immense increase in output attained since the war began.]

Economy of Materials.

It was not until our production was assured that we were able to set ourselves to improving our designs, and then came the necessity of economizing materials, to dampen the enthusiasm of our designers again. We have had to reduce the capacity of our favorite 18-pounder shrapnel to allow of the use of lower grade steel. We have had to replace our well tried propellant, cordite, by nitro-cellulose; to reduce the percentage of T.N.T. in our explosives; to let brass displace aluminum, and cast iron displace brass, in our fuses; and to change the form of our driving bands to economize copper. But everywhere again science has come to our aid once the need has been fairly put.

Production.

Judging from our experience, the guiding rules in order to insure production would appear to be to develop to the utmost the production of what can be got easiest—remembering always that there will certainly be a demand for changes, and to press on research in the meantime so as to be ready to change to more efficient patterns as soon as the position allows of it, watching always the tactical changes so as to be able to anticipate demands. Thus the business man and the scientist have full fields for their activity, but both will have many discouragements to face, for in war they must be controlled by the needs of the soldier.

When the scientist after weeks of intense study has solved the secret of some wonderful idea for improvement in design, he will be told that it is not worth the loss of output it will entail; for to every change—however fascinating or desirable in itself—must be applied the touchstone: "How much will it retard output?" Just when the manufacturer is priding himself upon the introduction of improvements in method which will shortly double his output, he will be told to shut down.

So it is, and so it must be—*war is not, and never will be a business proposition.*

Wear of Guns.

The output of new guns has not only to provide the numbers required to bring the army up to the desired strength, but it has to meet the wastage due to accident, to the enemy's fire, and to wear, of which the last completely overshadows the other two.

As long ago as 1916, General Gossot said in my hearing, "Up to this the guns have eaten up shells; we shall now see the shells eat the guns." He was absolutely right. At the beginning we had

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little anxiety, for so admirable was the material of which our guns were made that their lives proved in practice to be far longer than had ever been anticipated. But as the output of ammunition increased they began to give out, and it may interest you to have some figures as to what the "lives" of the more important natures are. [Tables were presented showing the average life of guns and howitzers.]

Needless to say that the search for a cure has been pursued with vigour, and this is a matter in which there is a great field for science; a field which has not been overlooked in this country, as witness the learned paper on the subject by Dr. Howe in the *Transactions of the American Institute of Mining Engineers* of last February. There is no doubt that the intense heat caused by prolonged rapid fire has brought on the guns a strain which was never anticipated, and in France and Russia and Italy I found that deterioration in the quality of the steel used since the war began was thought to have been a contributing cause. With us this latter does not appear to have been the case, except perhaps, in individual instances, nor have we been able to determine whether carbon, nickel, or nickel-chrome steel gives the best results.

Reduced charges have now been introduced. Strict rules as to pauses to cool the guns have been promulgated, and various substances are now used for greasing the bore. We hope to get good results from our latest mixture, the composition of which has, needless to say, been communicated to your ordnance authorities.

Repair of Guns.

But all the above are merely palliatives. We have to face the fact that our guns have all a very limited life under modern conditions. One battle may be enough for some, and so the question of *repair* has become one of great and growing importance. Facility for relining must ever be in the mind of the designer, the provision of sufficient plant for repair must be included in the outfit for war, and a regular system of withdrawal in rotation instituted. Just as in a fleet some ships must always be in dock if the docks are not to be congested by a sudden rush, so must a regular system of sending guns for relining be maintained.

With the ocean between your guns and your arsenals, the problem is a very difficult one for you.

Wear of Carriages.

And the same thing applies to the carriages. The delicate mechanism which is an essential feature of a modern carriage, even in field artillery, requires skilled and careful handling, especially when called upon for such a strain as is imposed by long continued rapid fire, with its consequent heating of all the parts, expansion of oil in the buffers, and so forth. It has always been the boast of artillery officers to know and care for their equipments, but the entry into action of large bodies of newly-raised artillery in 1916, synchronizing as it did with the enormous development in ammunition supply, undoubtedly led to a considerable amount of preventable damage. Where this struck us particularly was in the springs of our field carriages, and in the air recuperators of some of our heavier mountings. One divisional artillery commander told me

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in August that his guns had fired 7,500 rounds in six weeks, and that since the beginning of the action he had on an average 25 per cent of his guns always out of action from this cause. All the spring-makers in England were called into conclave—representatives of the design departments of all the great gun making firms were taken over to France, to see on the spot where the failures were. But no doubt the chief damage was due to the fact that in the heat of battle, inexperienced personnel had forgotten the constant attention buffers require. Great attention has since been paid to this part of the training, and after visiting many of the field workshops a few days after the commencement of the attack in Flanders, I was able to report that preventable damage was practically dead. But there are still, alas, some cases of prematures, and with the counter battery work that goes on now many cases of damage from the enemy's fire, so that our field workshops are still kept busy. Close up to the front you will find everywhere installed in ruined farms or under a tarpaulin shelter these ordnance workshops, containing a heterogeneous collection of damaged guns and carriages. From the store of "spares" it may be possible to put the damage right with some adjustment, or from three such "lame ducks" it may be possible for one or two to be made complete, and so the work goes on all night, and by dawn the guns are in their places in the line again. The work done by the officers and men who man these workshops is a very material factor in the great artillery struggle, but nothing can compensate for the daily care of the gunners, and I always thing the mottoes inscribed on the French 155-mm. Filloux guns should be on every gunner's heart:

"Le Canon bien tendu en vaut deux." "Soyez bons pour les freins."

I hope, gentlemen, that you will not think I have devoted too much of your time to this subject of production and repair, but it is one of absolutely vital importance to the efficiency of an army in the field, and it is one in which science has a great part to play.

Accuracy of Fire.

I had intended to tell you something of the development of the work of artillery in the field, of counter battery work, and of the "barrage," a word which seems to have captured the American imagination almost as much as "camouflage." But time does not permit, so I will confine myself as far as work in the field is concerned to giving you an idea of what has been done in the way of developing the *accuracy* of artillery fire during the war.

Accuracy of fire is of course the first essential to success in the artillery, and the first thing therefore that the good gunner does is to get as good a platform for his gun as he possibly can, and that probably means much heavy labor in digging deep, and gathering material—rubble, bricks, timber—from a distance. This search for material sometimes leads to amusing scenes.

Care of Ammunition.

But however solidly a gun may be supported it can not be expected to give uniform results unless the ammunition is in good order. Powder and fuses must be protected from the weather, and this entails much labor and constant care. We had, for instance, great

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trouble when we first adopted nitro-cellulose powder because we did not realize how sensitive it was to damp.

Protection from the weather is not, however, all that has to be done to insure good shooting from the ammunition. Cartridges and fuses are made in *lots*, and no "adjustment" can quite get over the differences between these. Every effort is made to keep lots together, and the system of doing so is at this moment being greatly developed, but even with all possible care, lots will inevitably get mixed in their passage from the factory to the ship, from the ship to the depots, from these to the dumps, and so through the various échelons of supply till they reach the guns. Cartridges and fuses must therefore be sorted in the batteries, and the necessary allowances made when using the different lots. Somewhat the same thing has to be done with the shell, for when a large output of ammunition is to be obtained from all sorts of factories it is out of the question to reject all which are not exactly within the strict limits of weight. They are accepted but with the weight marked upon them, and these again must be sorted and the necessary allowances made.

Calibration of Guns.

The next thing the artilleryman has to think of is the age of his gun, or rather how hard it has lived! As a gun wears, its accuracy and its range fall off. The former can not be calculated, though it must be allowed for: the latter can, and the loss of muzzle velocity in each gun must be found and allowed for. This is what we call "calibration," and it has to be repeated with each propellant, and, in a howitzer, with each charge. It is usually carried out on the front, because we prefer, whenever possible, that every shell should have at any rate a chance of killing a German. To enable it to be done the topographical sections provide batteries with maps, mounted so as to avoid errors due to shrinkage or warping, and showing accurately not only the positions of the guns and observing stations, but also such datum points as may be desired in the enemy's lines.

Error of the Day.

Having by this means found the errors of the guns, a battery commander has next to think of the error of the day, rather of the moment. He must ascertain and allow for the height of the barometer, the temperature of the air, the temperature of the charge, and the force and direction of the wind for a given time of flight, and here he has to depend on his scientific friend "Meteor" who sends to him every few hours cryptic telegrams.

Error of the Gun.

And yet after all this meticulous care, we have to recognize that a series of rounds fired at the same elevation will not fall on the same spot, but will cover a rectangle varying in size with the gun and the range. The size of the "50 per cent zone"—the length and breadth of which are a quarter of those of the 100 per cent zone—is given in the range table of each gun, and this has to be continually in the mind of the battery commander, for without a thorough realization of it he cannot judge how many rounds will be required to accomplish such a task, as, for instance, the destruction of an enemy's battery. But its most important use is perhaps to avoid danger of shelling

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one's own troops. Nothing is so distressing to an artillery general as to receive complaints from the infantry that his shells are falling in their trenches, and yet whatever the skill of his batteries this must happen sometimes, with the lines as close together as they are, unless this inherent quality in the gun is recognized and allowed for.

Difficulty of Applying Calculations in the Field.

I will not pursue the subject further, but remember that though the calculations may appear very simple to you, they are not so easy, given the conditions under which they have to be made—the absence of any conveniences, the presence of every disturbing element. It is very easy then to make an error which may have fatal results. One of my best battery commanders was killed by a shell from his own battery when himself conducting the fire from a trench from which he had cleared the infantry.

Observation of Fire.

But however confident he may be of the accuracy of the information furnished to him by his scientific assistants, and of the correctness of his own calculations, the good artilleryman will always do everything in his power to insure his fire being *observed*. The possibility of sending artillery officers forward with the advancing infantry had been hotly debated before the war and in some cases practised as far as this could be done in peace, so it did not take long to fall into the idea when the first halt on the Aisne gave the opportunity—and the demands that the work made on the enterprise and ingenuity of our officers caused it to be taken up with enthusiasm. The following example may bring home to you some idea of what this meant.

At one point on the Western Front there was a low ridge between the opposing front lines of trenches. Beyond the end of this ridge there was an offset in both lines. There were ammunition dumps behind the ridge and beyond the offset stood the ruins of a farm-house, from which a good view could be had of the German positions behind the ridge. One of our battery commanders discovered that he could get up to that farm-house at night. He went up one night and explored it and found that there was a gable still standing, and that the end of the gable had been knocked out by a shell, but that there were strips of drying tobacco hanging in the opening which he thought would give him shelter. So he got his telephone up there the next day, after many difficulties; he was only about 150 yards from the German lines. There he carried out a shoot which is a good instance of what I said about the importance of accuracy. Here was the ridge, and our trenches were just short of the crest. He wanted to shoot at the point beyond the crest. It was extremely difficult from the gunner's point of view to get a shell which would clear this crest and hit the objectives desired, for there was danger that the shell would hit the crest or drop into our trenches. He succeeded through his control of the fire by direct observation, although he had to carry all that out in a place where he could not move and where he was really in full view of the Germans almost within pistol range. It was one of the sort of problems that artillery officers are contiually attacking and solving in this war.

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Aeroplane Observation.

Almost simultaneously the aeroplane observer entered the field. The story of how the present system of communication between aeroplanes and artillery has been gradually developed is in itself a subject for a lecture. Now not only does the observer in the air observe our fire, he also proves the correctness of his observation by bringing in a photograph of the result, which is used also by comparison with the zone of the guns to check the accuracy of the work of the battery. I need hardly refer to the science that has been devoted to developing the means of communication and perfecting the system, but all those who have had real experience whether they belong to the Flying Corps or the Artillery, will I am sure agree that success will never be attained without the closest possible personal touch and sympathy between the observer in the air and the gunner below. They must know each other—without the personal equation, half the benefit of science is lost.

But practical experience showed the danger of relying too exclusively on aeroplane observation as liable to be put out of action by bad weather, while in any case the number of machines which can work on any given front is strictly limited. Great efforts are now therefore being made to develop all other possible means of observation. The balloon—the first cousin to the aeroplane—is of course very restricted in its zone, but it has the great advantage that the observer in it is in direct telephonic communication with the artillery—indeed it is nothing but an observing station in the air, which can be occupied by any artillery officer.

Observing Stations.

The ordinary observing stations have been developed in the one direction by camouflage which was first directed to this end, rather than to the concealment of the guns themselves; then to their elaboration—instead of the officer covering behind his precarious screen of tobacco leaves, he would be in a comfortable splinter-proof tower which had been ingeniously built inside the ruins; or sitting in the cellar, with his eye to a giant periscope, or perhaps a camera obscura.

Flash-Spotting and Sound-Ranging.

In the elaborately equipped observatories of the "flash spotters" the burst of every round may be accurately recorded by the intersections of three widely separated observers, and instantaneously transmitted to the plotting stations. There too will be registered the position of any gun that is foolish enough to open fire from an insufficiently masked position when the clouds are dark behind it.

Then the "sound ranger" too plays his part, as with his delicate instruments he registers the discharge of the enemy's gun—also, often enough, the burst of the enemy's shells. Their work must be done far to the front, and often with little or no protection, and I would like to bear witness to the gallantry of the distinguished savants who have let no consideration of personal safety or comfort interfere with the accuracy of their observations.

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Contents of R.A. Journal, October, 1918.

Ordre General No. 351. Q.G. le 16 Juillet, 1918. 221

Artillery Instruments not of Service Type. By Major L. A. Notcutt, M.C., R.A. 222

Remarks on Trench Artillery. From the United States "Field Artillery Journal". January—March, 1918. 245

TRANSLATION.

The Economic Effort of the Central Empires. Translated from "L'Europe Nouvelle," 21 August, 1918. Communicated by Temp. Major F. M. G. Du Plat-Taylor, R.G.A. 251

Authors are alone responsible for facts and opinions expressed in their papers.

Note.—Owing to the "Leaflet" accompanying this Journal being corrected up to the last day of the month, and abnormal conditions due to the war, publication will not take place for a further 14 days.

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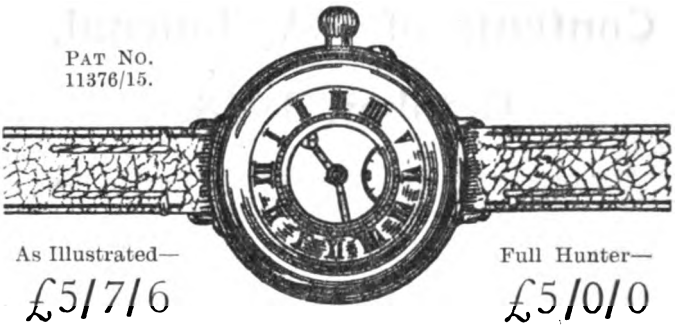

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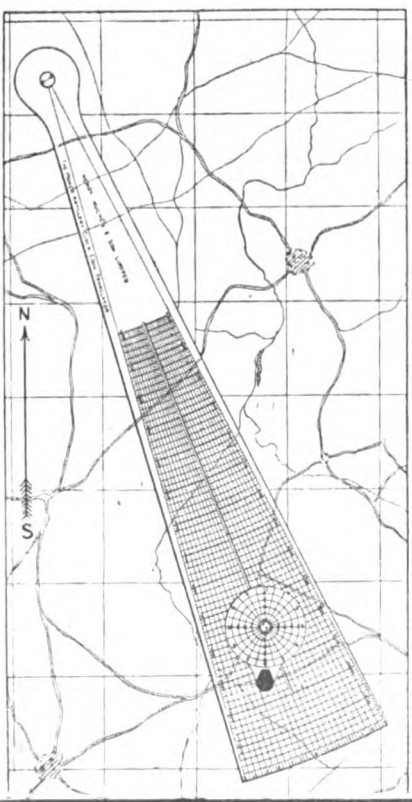

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ORDRE GENERAL No. 351.

Ve Armée.

Q.G. le 16 Juillet, 1918.

Etat-Major.

B. du Pérsonnel.

Le Général Commandant la Ve Armée cite à l'Ordre de l'Armée les Militaires dont les noms suivent :—

* * * * * * * * *

5e Batterie R.F.A., 45th Brigade, R.F.A.

"Dès le début de la bataille, l'ennemi ayant déclenché sur la position un violent bombardement d'Artillerie Lourde par obus toxiques, cette batterie continua sans les ralentir en aucun moment, ses tirs de barrage ou de contre-preparation qu'elle exécuta avec les pièces non détruites L'ennemi, après avoir ouvert un tir de barrage sur la linge principle, attaqua par le flanc la position occupée par la Batterie. LeCaptaine, J. H. Massey,* Commandant la Batterie, muni d'une mitrailleuse, à la tête du détachement des survivants, contre-attaqua immédiatement, aidé du Lieutenant C. E. Large, qui s'etait également muni d'une mitrailleuse, quoique grièvement blessé et du S/Lieutenant C. A. Button qui avait au préalable détruit toutes les cartes et papiers pouvant intéresser l'ennemi. Ce Vaillant détachement fut écrasé dans une lutte inégale. Seuls de la Batterie survécurent trois canonniers sans armes, renvoyés a l'arrière ayant la contre-attaque, et un canonnier qui, avec son mousqueton, réussit à se frayer un passage. La résistance héroique de cette Batterie eut une grande influence sur les suites du combat. Sa Vaillante conduite mérite d'être citée en exemple et fait grand honneur à l'artillerie de la 8e D.I. Britannique".

* * * * * * * * *

Le General Commandant La Ve Armee.
Berthelot.

* (Since awarded M.C. and reported missing.—*Ed.*).

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ARTILLERY INSTRUMENTS NOT OF SERVICE TYPE.

By Major L. A. Notcutt, M.C.

DURING the war, a very large number of instruments and charts have been invented to assist in solving artillery problems.

The object of this article is to provide a general review of such instruments, since is it apparent that many officers have independently invented identical instruments through the absence of knowledge of the work of others. In addition it is hoped that this review may indicate the lines on which further work might produce good results.

An instrument, or chart, which is to be of value to artillery officers must fulfil the following conditions:—

(a). It must be able to solve a given problem quicker than the problem can be solved by the user without the instrument.

(b). The results must be compatible with the degree of accuracy of which the weapon is capable.

(c). It must be easily carried.

(d). It must be reasonably waterpoof.

*(e). That the user can solve the problem, if necessary, without the instrument.

The first of the above conditions is the main factor but applies differently to each individual user.

Thus, "A", who finds any form of mathematics an unloveable task, would appreciate an instrument to solve a certain problem which "B" considers a matter of simple arithmetic. Therefore "A" praises, and "B" reviles, the instrument.

"C" may have a similar taste to "A", but is an adept on the slide rule, and therefore agrees with "B" about the particular instrument.

"D" uses another sort of instrument and has no use for A's instrument or a slide rule.

Finally there is "F", who by experience and tuition solves the problem without instruments or mathematics, though he must not be confused with "G", who is brainless and prejudiced, and tries to bluff out his ignorance by imitating "F".

The pre-war equipment solved TOB problems and provided the Artillerist with simple formulæ to calculate problems such as concentration—flank A.P., etc. The gunner however, now must solve far more difficult problems which arise owing to the principles of Artillery employed being modified for trench warfare.

* This point is insisted on by Gunnery Schools. But how many officers could solve a T.O.B. Problem without a field plotter?

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The principle problems dealt with, in this review, are:—

(1). Angles, measurement of
(2). Bearings, measurement of.
(3). Clearance to crest.
(4). Clock code corrections.
(5). Concentration, angle of sight, etc.
(6). Corrections for barometer, thermometer, M.V., etc.
(7). Map range and line.
(8). Observation corrections, one observer to a flank.
(9). Observation corrections, two observers, cross.
(10). Wind.
(11). Miscellaneous.

It will be noticed that many instruments designed to solve mathematical artillery problems consist of a circular rotating disc. The reason for this is that the circular form of calculator is simpler in manufacture than the ordinary type of slide rule, and secondly that several gunnery problems involve trigonometry, which require graphical solution, the circle being the most convenient form.

The author holds that for practical purposes, artillery instruments should be extremely fool-proof, not that they are used by fools, but rather that, under field conditions, simplicity of manipulation is essential for accurate work. For this reason he personally prefers the type of instrument on which the answer is indicated in some clear manner.

Measurement of Angles.

In normal circumstances the battery director can perform all the angle measurements required; but it sometimes happens that in an O.P., which has a very narrow slot, a director is a very inconvenient instrument, as when it is set up it takes up the whole of the embrasure, obscuring the view for field glasses.

In these circumstances a pocket sextant is a useful instrument, but is slow to read.

Bearings.

The compass is an essential instrument, but the type in service issue does not include some of the advantages obtainable in the purchasable article.

There is little doubt that the liquid type of compass is more convenient for service use than the non-liquid type.

There are four well-known types of liquid compasses on the market, and these vary mostly in their method of reading the bearings. They are illustrated below.

From an Artillery point of view, prismatic compasses appear to require improvement so as to include the following features:—

(1). Compass to be adjustable so as to read direct true, grid, or magnetic bearing as desired.

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The Creagh-Osborne Artillery Pattern Compass can, with slight modification, be used to read true instead of magnetic bearings.

(2). Compass should be readable with equal accuracy day or night.

Fig. 1.

LIQUID COMPASS with illuminated outer scale of bearings, which can be read and re-set at night.

The luminosity is derived from a radio active compound which is always active and does not require exposing to light.

The dial is divided round the outer edge to single degrees and can be read through the prism to ½ degree, the numerals being reversed for the purpose. An inner circle is divided to every 5 degrees with numerals arranged in the same manner as on an ordinary compass. This inner circle of degrees is for direct readings and for use with plane table or map.

The outer scale of bearings on the Verner principle is divided on transparent material and revolves on the upper surface of the compass box carrying with it a luminous indicator. A clamp prevents the scale from shifting after it has been set. The outer scale is illuminated by a patch of radio active compound and can be read and re-set at night. It is figured at every ten degrees, the final zeros having been omitted to give room for larger figures, thus 15 represents 150 degrees.

The hinged metal lid is provided with a glass window on which a sighting line is etched. Inside the lid are two self-luminous patches of radio active compound for aligning the compass at night, and these are protected by a transparent shield.

Notches in bow ring of handle and lid serve for map reading and plane table work, and a friction ring countersunk on the bottom of the compass box prevents slipping when used on a plane table.

The compass box is 2 inches diameter by 1 inch deep.

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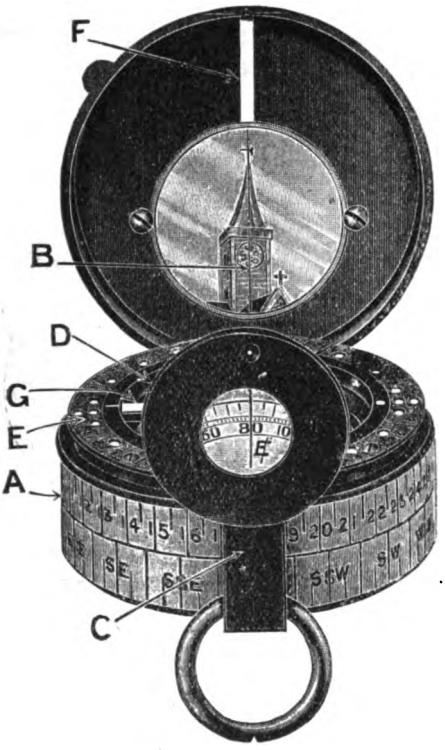

Fig 2. Night marching bearings can be set in the dark.

Fig. 3. The "Blacker" type of Creagh-Osborne Compass.
This is a convenient type of compass for wrist work.
It is divided every 2° and the divisions are painted with radio-active compound.

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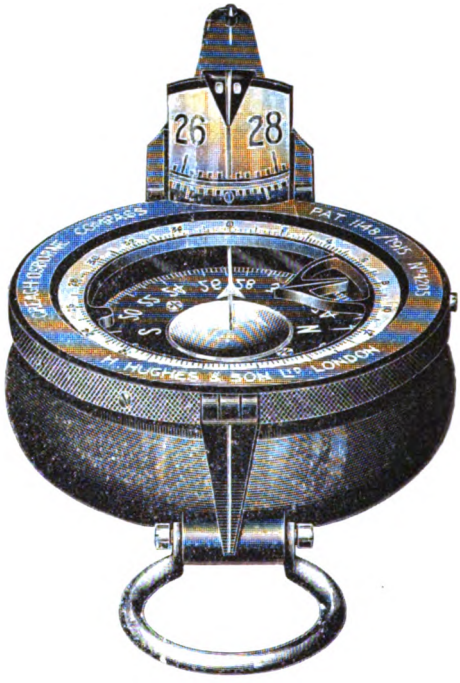

Fig. 4.

The Creagh-Osborne Artillery Pattern Compass.

This compass includes the following features:—

Liquid type.

Every 2° painted radio-active compound.

The compasses shown in Figures 3 and 4 can be read equally well day or night, but are only graduated to every 2°, and thus cannot really be read more accurately than 1°.

Clearance of Crest.

The question of crest (or obstacle) clearance occasionally occurs, generally with gun batteries, and may be a problem of vital importance.

Two instruments have been described in the 'Journal of the R.A.', No. 7, Vol. XLIII and No. 10, Vol. XLIII, but both of these still leave the last part of the problem to be solved, i.e., the *safe minimum clearance*. For example—our troops hold the crest of a hill, and a gun has been pushed forward for C.B. work. The minimum clearance works out at 5300 for some vitally important target whose range is 5375. The question it—can it be engaged without endangering the troops on the crest taking into consideration the 100% height zone to the *target*.

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In a note by Capt. J. N. Kennedy on page 378 of Vol. XLIII R.A. Journal (Jan. 1917) it is explained why the drill book method of finding clearance is unreliable to the extent of being dangerous when the crest is close.

A solution of the problem is given by Lt.-Col. H. W. Hill, D.S.O. on page 166, Vol. XLIV of the R.A. Journal (July 1917).

Lieutenant Higgins, C.F.A. suggested an amendment to Colonel Hill's rule in R.A.J. No. 9, Vol. XLIV.

By adding a table of *safe minimum clearances* at the back of either of the slide rules described, the whole problem could be solved.

The conscientous B.C. calculates his minimum ranges for crest (or obstacle) clearance at different bearings, as a necessary part of his defence scheme.

The second problem is the obstacle or crest clearance at the far end of the trajectory. This occurs in barrages. For instance, a barrage is to pass over a crest and remain stationary a few hundred yards beyond, in a valley. In practice, however, the crest may impede the trajectory causing our own troops to be subjected to percussion fire. The obvious solution is to work out the angle of reverse slope and check that it is less than the angle of descent. This is tedious and requires very careful checking to see the maximum angle of slope has been calculated.

Another means is by strips of paper with cotton lines for height of trajectory. This method, however, requires very careful use.

Clock Code Corrections.

"N.C.T." in an article to the R.A. Journal, August 1917, suggests that no instrument is necessary other than the face of a watch.

This is an example of the personal factor, in an officer preferring to perform mental arithmetic to using an instrument.

The method that he describes was used by the majority of heavy batteries very early in 1915, until other methods were introduced.

Whether the B.C. applies the exact corrections or not is a matter for his own opinion, but there is no truth in the statement that R.F.C. officers cannot give accurate observation. The employment of marked aero photos has led to extremely accurate observations, so much so, that there might be an advantage in observing to half hours on the clock so that the line correction could be obtained more accurately.

The original instrument used was the "Artillery dial Range Corrector" of which I am stated to be the inventor. As this instrument is often criticised nowadays, I should like to take this opportunity of saying that I do not defend it as being a good design. It was evolved in March, 1915, and published shortly afterwards. I did not see any proof, nor was I consulted as to the size and material of its manufacture.

A modification of this instrument is described in Fig. 4A.

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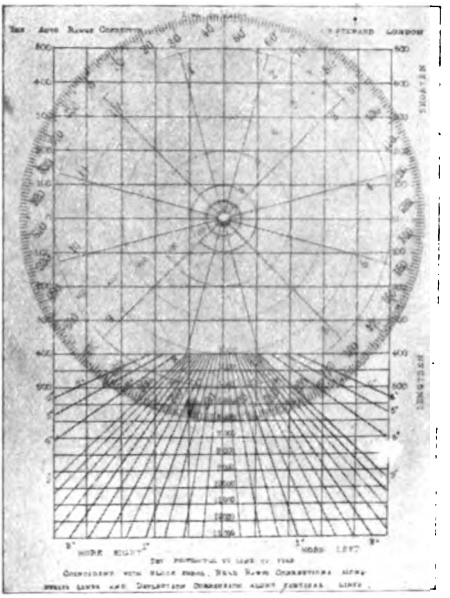

Fig. 4A. The Auto Range Corrector.

A transparent circular disc, the outer edge of which is divided to degrees, and upon which is scribed concentric range circles, and clock face radial lines revolves upon a rectangular base of ivorine. This is ruled with horizontal and vertical lines, representing 100 yards, equivalent to the distance between the range circles. On the lower part of the base radial lines are drawn to represent every 15 minutes right and left deflection for ranges of 2,000 to 13,000 yards. A horizontal line passing through the centre of the disc indicates the range zero, and a similar vertical line, denotes the line of fire.

The circular disc is set to the true bearing of the target and the position of the shot is found from the Aeroplane signal. The horizontal line which cuts this position denotes the necessary amount to shorten or lengthen the range, and by inspection the corresponding vertical line indicates the angular correction for right or left deflection at the particular range used.

This is a modification of the Service 'Artillery dial range corrector'. Being made of celluloid it is not damaged by wet and mud.

An ingenious instrument "The Power Artillery Clock Code Translator" is described in Fig. 5. This instrument is used on a map mounted vertically, and automatically sets itself north and south.

The instrument consists of a celluloid sector, graduated in 100 yds. to 11,000 yds. (on 1/20,000 or 1/10,000 scale) with degree markings for 6° either side of zero.

The instrument is pinned to the battery position. The disc is then slid out until it is over the target, where it can be pinned. If the map is mounted vertically, the disc will revolve automatically

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to the North and South position, thus doing away with the necessity for setting it.

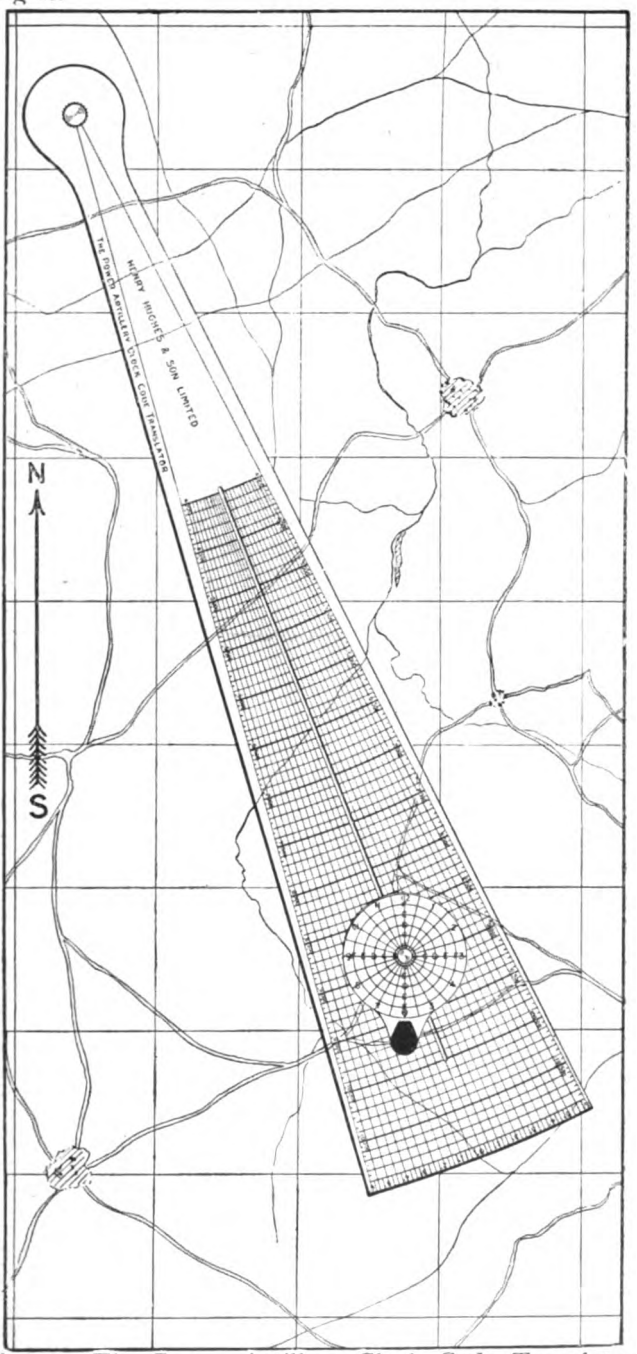

Fig. 5. The Power Artillery Clock Code Translator.

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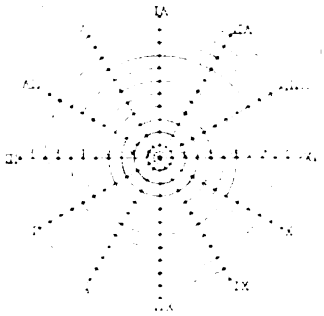
Where a fighting battery map board is available, the simplest instrument is the celluloid square on the same scale as the map, described in Fig. 6.

Fig. 6.



The instrument is made of celluloid to the scale of 1/10,000 or 1/20,000. At the intersection of each hour and each circle there is a hole enabling the map to be pricked through.

Instruments for Calculating.

Angle of sight.
Distribution or concentration.
Displacement.
Parallelism.

These problems are most simply solved on a slide rule, and whether it is of the ordinary type or whether specially calibrated for artillery problems is a matter of personal choice. The different methods are:—

1. 5″ Slide Rule with magnifying cursor. This is extremely convenient for the pocket, and has greater power of accuracy than is actually required for ordinary field work.

Many gunners instinctively avoid a slide rule, as an instrument which requires a brainy person to obtain results from. This is absolutely erroneous. The truth is that to understand the working of a slide rule *fully*, undoubtedly requires a clear mathematical head; but to perform the few mathematical problems required by a gunner is *an absolutely simple matter.*

The use of the slide rule for gunners is illustrated and described in one of the "Gunners pocket notes" series published by Forster Groom, Charing Cross, entitled "The slide rule", by Lieut. John F. Martin. Each problem is taken separately and an illustration of the proper setting for the slide rule included. The explanations are thus so simple that a child could use the rule.

NOTE.—All ordinary slide rules are identical, except as to their size and maker.

The other, and more convenient form is the watch pattern. It is, however, differently calibrated from the normal type of slide rule, and accordingly requires special instructions.

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II. The Hill slide rule.

This rule solves all ordinary gunnery problems.

III. Map Marking.

It is possible to mark up a map for a particular battery position so that 'angle of sight' and 'concentration' can be read off at a glance. This may be useful to Field Artillery and Heavy Batteries which are required to open fire on a target given by map reference as quickly as possible. In such cases, where the range, bearing, angle of sight, concentration, wind correction, etc., must all be worked out, the saving of a few seconds on any of the operations is worth considering.

IV. The case of calculating for large displacement problems has been dealt with by Captain Sheppard, R.A., in R.A.J. No. 10, Vol. XLIV.

Corrections to Ballistics.

The only instrument of which I am aware that deals with this problem is described in Fig. 7.

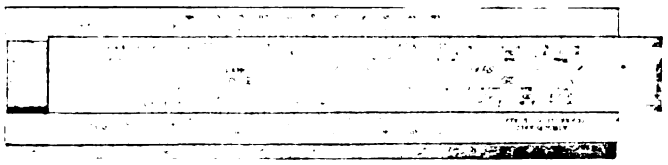

Fig. 7.

Slide Rule for giving the correction to range for charges from the normal. Scales give corrections for Wind, Barometer, Temperature of Air and Temperature of Charge for every 500 yards of range from 2,500 to 6,000 yards, corrections for ranges nearest the true range being taken for intermediate ranges.

Considering the amount of time expended throughout the day in calculating these problems it is surprising that no good instrument has been introduced. The main difficulty is that each type of correction has its own idiosyncrasies, which prevents a simple instrument being possible.

There is no difficulty in designing a modified adding machine on which the barometer, thermometer readings, etc., could be set; the 'map range' set off; a handle turned, and 'gun range' appear instantly. However, such an instrument would be expensive, but provided it was reasonably small and light, it should be useful, as it would be very rapid and fool-proof. Or as an alternative, the instrument could be in the form of a map measuring scale which on being set would measure gun range instead of map range: in addition it could take into account the effect of wind on range at different switches. Both these instruments are possible but it is doubtful whether they would not be too internally complicated to be practicable.

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Captain Brittain, R.A., describes in R.A.J. No. 9, Vol. XLIV. a "disc meteor" (this title appears rather a misnomer) which mechanically solves range corrections. This is an improvement on the Atmospheric slide rule described in Fig. 7 in that the provision of a cursor enables the various corrections to be mechanically added or subtracted. Although this is better than nothing for a gunner who prefers instruments to arithmetic, the instrument can be redesigned so that the corrections are mechanically added or subtracted from map range so that the answer is given as gun range. In Captain Brittain's calculator, corrections for muzzle velocity and fuze shape could easily be included. Also, personally I should prefer the wind corrections to be for different velocities instead of different angles, because it is easier to resolve the wind than to calculate the proportional wind correction necessary for a velocity other than 30 f.s. for which the calculator is graduated.

Map Range and Line.

In that map shooting is now of enormous importance, it follows as an obvious fact that accurate measurement of map range and line is of paramount importance. This, however, is not always realized. If the line to a long-range target is measured on a map with an ordinary gunner protractor, the line may easily be determined as much as 50 yards off the target.

NOTE.—It does not strictly come within the province of this article, but the author has seen home-made fighting maps on which large protractors have been used, and all precautions taken to make measurements as accurately as possible, but proportionately accurate means had been taken to ensure the plotting of the battery position being right, and in one case in fact, the battery position had been misplaced by 50 yards; the result being that before anything else was taken into account, there would be a combined error in range and line of 50 yards. Obviously the efforts taken by this battery to obtain accurate corrections were spoilt before they were commenced.

The first principle of measurement of map range and line, is that the instruments used are accurate, and capable of being read, to within the close-shooting capabilities of the battery. This may be taken as 5 minutes and 12½ yards.

Of scales for measuring map range, there are many kinds. The wooden type is apt to chip and warp; the celluloid type to alter its length with varying atmospheric conditions. In my opinion the most suitable type is the steel tape, a form of which is shown in Fig. 8.

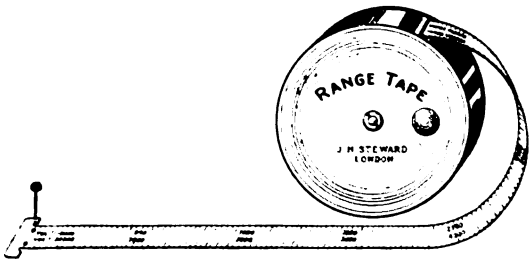

Fig. 8.

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Range and Switch Tape.—A pocket steel tape 3 feet long coiled in a nickled silver case. The 4 edges of the tape are divided as follows—10,000 yards on the scale of 1/10,000, 20,000 yards on the scales of 1/20,000 and 1/40,000, and 40,000 yards on the scale of 1/80,000. There is also a scale of 1 foot divided to inches and tenths, and a comparative scale of centimetres and millimetres.

The end bit of the tape is so shaped that is can be hooked on to a pin stuck in a map board when the tape can be drawn out to the required length. The pinholes are at the zero points of the four yard scales. By using the tape combined with a protractor pinned to the battery position the angle and range to any target can be read at one operation.

Of protractors there are legion, but bearing in mind that the angle should under ordinary circumstances be measured to 5 minutes, the question of size at once becomes important.

Protractor Graduations at 10 minutes intervals.

Radius 20 inches

Radius 15 inches

Radius 10 inches

Radius 7·5 inches

The above sketch shows graduations 10 minutes apart with protractors of different radius. The protractor with 20 inch radius, can obviously be read with the greatest ease. With a radius of 7·5 inches it can be estimated, but not with certainty. It is then a matter of personal taste what is the minimum radius to enable 5 minutes to be read comfortably.

The most convenient way of measuring range and line is by a combined instrument.

Fig. 9 shows the usual large scale celluloid sector.

Fig. 10 shows a protractor with range scale attached. This form is convenient for temporary use until some form of fighting map can be prepared.

Fig. 11 shows a very simple instrument for preparing a fighting map.

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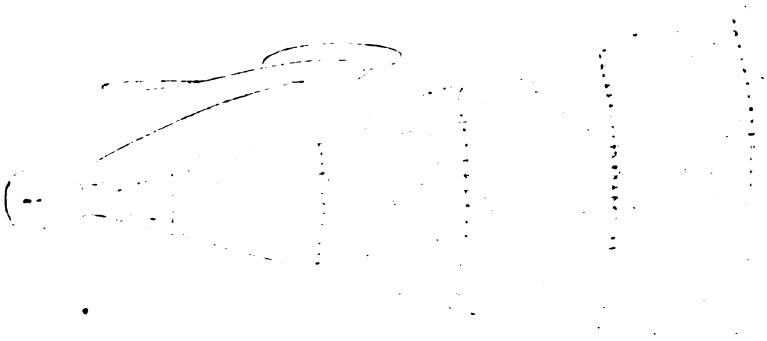

Fig. 9.

Protractor, made of transparent material, 18 inches radius, with gut cord at centre. Left straight edge divided to the scale of 1/10,000 up to 10,000 yards, every 100 yards being marked with range arcs scribed at every 1,000 yards. Right straight edge divided to the scale of 1/20,000 up to 20,000 yards, with every 100 yards marked. Arc of 30° reading from left to right, every 10 minutes being marked on the extreme edge. Radial lines at every 30 minutes carried down from the extreme edge to 6,000 yards. Radial lines at every degree from 6,000 to 4,000 yards and at every 2 degrees from 4,000 to 2,000 yards on the scale of 1/10,000.

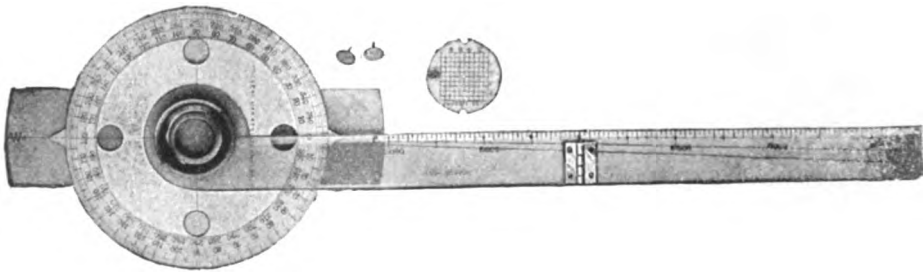

Fig. 10.

Artillery Map-reading Protractor.

This instrument can be had with an 8-inch protractor, and scales for 1/10,000 up to 11,000 yards or 1/20,000 up to 12,000 yards.

The protractor is of ivorine, which makes it easy to read in a bad light.

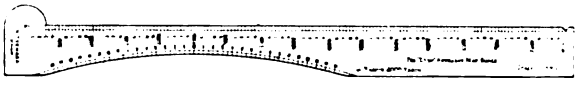

Fig. 11.

The Eton Artillery Scale for use at the battery position for ascertaining the range and switch to any target and also for use at the observing station for map reading and ranging. The scale is

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made of transparent material with the bevelled straight edge divided to every 25 yards up to 8,000 yards on the scale of 1:20,000, and with a pinhole at zero for pinning the scale to the battery position or to the observing position on the map. A notch is cut to receive a pencil point for drawing a segment on the map with a radius of 8,000 yards corresponding with the zone. There is also a second notch giving a radius of 4,000 yards for use at an observing position. On the opposite edge of the scale is a protracted arc of 30 degrees, giving 15 degrees right and left of zero, and divided to every 15 minutes. This arc is cut to a radius of 8,000 yards and is used for marking degrees and minutes along the segments. When used on a segment with a radius of 4,000 yards 30 minutes on the protracted arc is reckoned as a degree.

This instrument provides a very portable means of preparing a fighting map.

Flank Observation.

This is a difficult problem, and one in which an instrument or chart is very valuable.

When an officer is required to carry out several long series during a day when the observation light is not very good, and the targets are small, and the ranges long, the worry of continuous mental arithmetic when the M.P.I. seems reluctant to get on to the target, is a factor which undoubtedly eventually affects good shooting.

In cases of engaging small targets where a large number of rounds are necessary for a probable hit, accurate combined corrections are necessary, but with the average observer and a combined factor of, say, ·78, it will be "·8" at the beginning of the day; "¾" at noon, and "call it 1" at the end of the day; and if this is on a small target, it isn't quite good enough.

My personal belief is that to the average man, the solution to a problem which is likely to give the best results in the long run is a graphical one. It may not be as accurate, but is less liable to mistakes.

Other than the grid plotter, I only know of two graphical methods; one of which is described in the Flank Observation Corrector described in No. 10, Vol. XLIV.

If the deflection and elevation factor method is used, a nomographic card such as described on p. 199 of Vol. XLIV, R.A. Journal (Sept. 1917), is a rapid means of determining the factors.

Double Line Observation.

Fig. 12 describes an instrument which solves the problem direct. The 'grid plotter' appears the best all-round instrument for this purpose.

The instrument consists of a fixed disc for the left observer marked in yards; a revolving disc which can be set in reference to the fixed disc to the angle RO—target—LO; a rotating strip representing the line of fire; two logorathimatically graduated discs for correcting the readings to the respective ranges RO—target

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and LO—target; and another graduated disc for converting yard correction to elevation.

When correctly set, and after a certain amount of practice, the corrections may be rapidly computed.

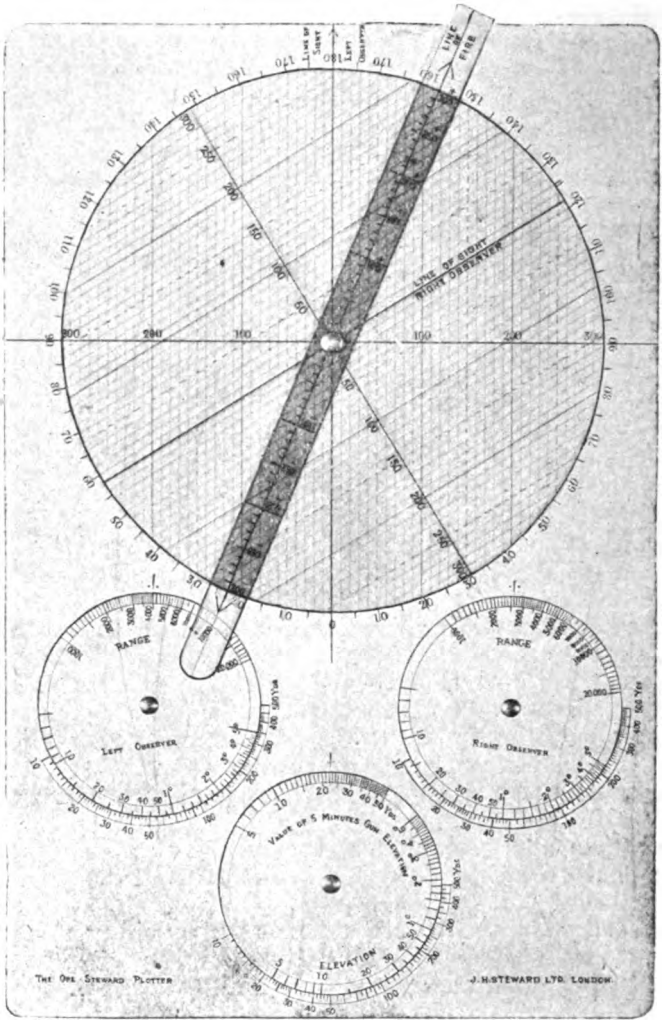

Fig. 12.

Wind Calculators.

This problem is particularly amenable to mechanical calculation.

The necessary data is:—

A. Velocity of wind for mean height of trajectory.

B. Bearing of wind for mean height of trajectory.

C. Angle between bearing of wind and line of fire, expressed either as:—

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STRUMENTS.

problem ng to be med.	Remarks.
e correc- line and an figures tables.	See R.A.J., No. 7, Vol. XLIII. Answers given in f.s.
	See R.A.J., No. 8, Vol. XLIII. Answers given as factors by which velocity of wind is to be multiplied.
s. wind. ly by of wind, 20 f.s. by 4 etc.	
..s. wind ly by wind.	See Fig. 13, page 238. Rather easier to read than above, as the answers appear at windows instead of having to be searched for.
f.s.	See R.A.J., No. 9, Vol. XLIV. In simple diagramatic form.
il.	See R.A.J., May, 1917. Requires different disc for different strength of wind.
il.	See Fig. 14, page 238.
il.	Similar to Layton but designed for use with "zero line" method.
ly by of wind.	See R.A.J., September, 1917. Similar to Layton.
to.	See R.A.J., September, 1917. Consists of squares placed one on the other at the angle between the wind and line of fire.
to.	Section of 14,000 map mounted on instrument. Pointer is set over target when answers appear at a window. Different disc required for each charge.
to.	Similar to 4 but has changeable back for different charges.
il.	See p. 304, No. 9, Vol. XLIV. Nomogram.
il.	Requires a roll of graduated paper for each weapon. Answer is given as a corrected range and line correction.

endently invented by others. The names are given

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(i) { Bearing of wind.
{ Bearing to target.

(ii) Angle between line of wind and line of fire.

or (iii) { Bearing of wind.
{ Bearing of zero line.
{ Angle, right or left of zero, of line of fire.

The above data must be resolved trigonometrically into:—

D. Velocity of wind along line of fire.

E. Velocity of wind across line of fire.

The actual effect of D. and E. must then be calculated for the muzzle velocity, ballistic coefficient, and Q E of the particular weapon under consideration, and the proper corrections accordingly made.

Very many instruments have been designed to solve or partially solve this problem. No instrument can be considered 'the best', as the selection of the most suitable instrument is purely a matter of personal opinion, depending mainly on the type to which each particular user is accustomed.

Reviewing the instruments in the inserted table. Class I are very simple and can be made by anyone in a short time.

Class II are simple to read, but can only be employed with guns.

Class III are not so simple to read as Class II, and in choosing between them, it is a question whether the user finds it simpler to read the instruments of Class III or perform the arithmetic with Class II.

In Class IV Nos. 9 and 12 are self-contained—12 being simpler to read but more complicated to make—and Nos. 10 and 11 require parts to be changed according to the charge employed. No. 10 requires a section of a 1/40,000 map mounted on it, and is then the most fool-proof of all the instruments on the table, but it is the most expensive to manufacture. No. 11 has no advantage over the tabular form of wind corrections given in recent range tables.

In Class V No. 13 should be useful to anyone accustomed to using monograms. No. 14 is in my opinion the simplest instrument of all, but is difficult to make locally, and the rolls of paper are tedious and complicated to graduate.

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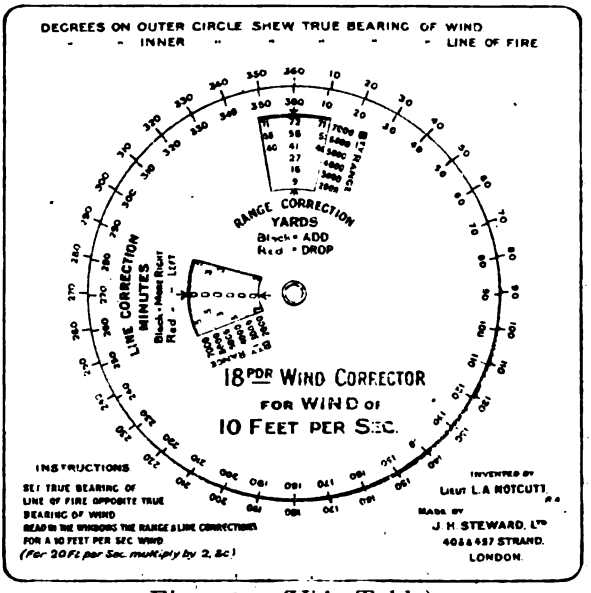

Fig. 13. (Vide Table).

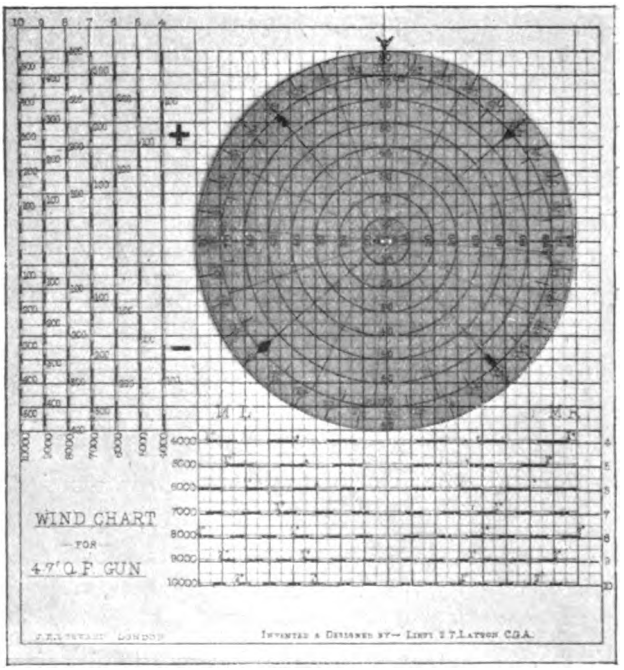

Fig. 14. (Vide Table).

This instrument is only applicable for one particular type of gun with a particular charge and shape of shell.

The circular disc is set for bearing to target and then the range and line corrections can be read off for the direction and strength of wind for the range.

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Miscellaneous Instruments.

1. Telescopes.
2. Probability problems.
3. Night reading instruments.
4. Map boards.

1. Telescopes.

The problem of making out enemy works and movement when in an O.P. which is narrow and confined by unavoidable circumstances, with lower power glasses is a difficult one.

Probably the most useful telescope to the gunner is that of the 'Davon' type, illustrated in Fig. 15. Owing to the optical principle on which it is designed, it is much more compact than the ordinary type. This fact makes it very useful for employment in confined O.P's.

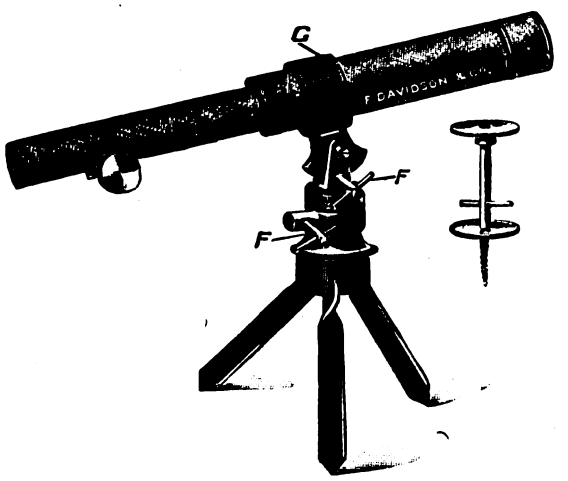

Fig. 15.

"Davon" Micro telescope with miniature director stand.

There are two types—one 12¾" long weighing 18 ozs., and the other, admitting more light, 14" long weighing 32 ozs.

With either of the above eyepieces with the following magnification can be used: 16, 20, 25, 30, and 40.

A small director can be fitted as shown, or as an alternative a gimlet fitting can be used which can be fixed into trees, etc.

2. Probability.

The problem of calculating the probable number of shell that should hit a target of given dimensions is not an essential, but is often a very useful problem to have solved.

3. Night Reading Instruments.

Almost all operations that a gunner requires to perform by day have to be repeated by night. When close to the enemy, a flash lamp is prohibited, and this fact often makes considerable difficulties for gunner and other officers.

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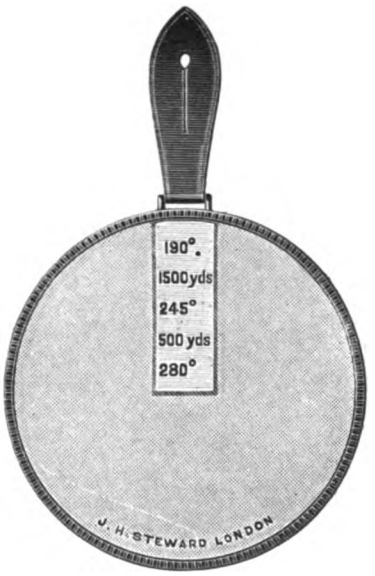
Means are provided for reading watches and compasses at night, but it is often just as necessary to read maps and memoranda.

Fig. 16 shows a luminous tablet on which can be written notes. The writing is made visible as required.

Fig. 17 shows an instrument for reading maps.

A map board designed to fold up is shown in Fig. 18.

Fig. 16.



The tablet is mounted in bronzed metal and is 2 inches diameter by ¼ inch thick. One face consists of translucent glass with frosted surface so as to receive marks from a pencil. Underneath the glass is an oblong patch of radio active compound possessing sufficient luminosity to make legible at night any writing on the glass that is brought over the luminous area. The whole surface of the glass is available for memoranda, and the glass is mounted in a revolving ring so that any portion of its surface can be brought over the luminous patch as shown in the illustration.

The reverse of the tablet consists of a slab of celluloid on which memoranda can be written for use in the day time.

When there is no further use for the memos they can be sponged off or removed with rubber.

Fig. 17.

This instrument is treated internally with radio active compound, and enables the user to read a map at night. The absence of reflected light makes this useful near the evening, when the absence of light is essential.

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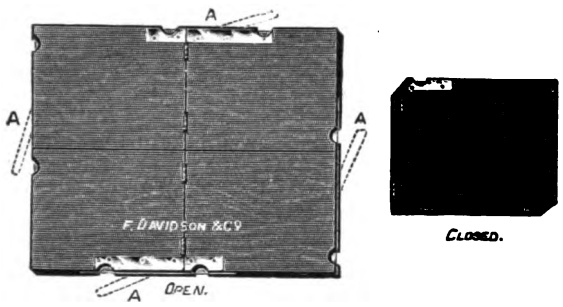

Fig. 18.

Pocket Plane Table.

Each quarter of the table is slotted. The flat brass fasteners "A" "A" "A" "A" are inserted in the slots to maintain rigidity.

Folds to 7½″ × 6″.

Opens out to 15″ × 12″.

Weighs 18 ounces.

Conclusion.

During the war, the production of large scale accurate maps, and forward observation posts have done away with 'TOB' methods.

The unavoidable necessity for a considerable percentage of the total ammunition fired to be unobserveable has forced, even the prejudiced and unbelieving, to take into consideration every kind of ballistic correction.

These two facts considered together have completely revolutionised gunnery methods from the pre-war standard. But since no two battery commanders would, at present, be in complete agreement as to the drill and procedure to be adopted as the standard, gunnery methods are largely individual to battery or brigade commanders.

The gunnery calculations which have become unavoidably necessary, during the war, are all difficult and complicated (particularly with howitzers). When the methods which other branches of the service have adopted to simplify and expedite the solution of their problems are reviewed, it is really an astounding fact that the Royal Artillery should be content to spend so much time (often at moments when the saving of seconds is a vital matter) performing tedious calculations when it seems likely that instruments *can* be designed which will solve the problems more rapidly, more accurately, with a greater certainty of a correct answer, and with an absence of any mental effort.

The majority of instruments described in the R.A. Journal, or purchaseable from instrument makers, are—what might be termed—of rudimentary type. This is due to the fact that they have to be designed so as to be simple from the point of view of manufacture and graduation, and to be moderately inexpensive. Consequently such a set of instruments could be reduced or augmented to any desired standard. For howitzers, the set would require more complicated instruments.

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The majority of instruments described in the R.A. Journal, or purchaseable from instrument makers, are—what might be termed—the rudimentary type. This is due to the fact that they have to be designed so as to be simple from the point of view of manufacture and graduation, and to be moderately inexpensive. Consequently such instruments are apt to be difficult to read and complicated to manipulate, unless their designer is content to solve only a part of the particular problem (wind correctors are a good example). However, by elaborating the identical principles easily-manipulated and direct-reading instruments there seems no doubt that can be evolved.

In view of this fact, it appears to me that the *real* want of the gunner can be supplied, viz., a set of standard instruments, conveniently combined together, to solve all the problems.*

Although there can be little hope of this millenium during the war, owing to, firstly, the fact that the instruments are not yet entirely satisfactory, and, secondly, because few B.C's would agree as to the standard type, I do not think that the consideration of the details of such a scheme should be postponed on these accounts.

Hereunder, I briefly put forward my own ideas, merely as a basis for criticism.

Suggested Equipment for Gun Battery.

NOTE.—If the 'TOB' methods may be accepted as defunct, except where large scale maps cannot be provided, I believe that great advantage would accrue from the introduction of the *bearing* method of laying. A modification to the dial sights is necessary, enabling the layer to use any aiming point he selects, but always to set the dial plate to the true bearing to the target as ordered for the battery. This method has many advantages, but unfortunately, owing to the difficulty in carrying out the modification in the field, few gunners have had an opportunity of giving the method a test. From the point of view of artillery instrument design and employment the 'bearing' method allows considerable simplification.

B.C's. INSTRUMENT. (To be used in the battery).

Appearance.

Folding map board to take a standard size mounted map. (Attachment could be provided to enable B.C. to set several maps together with accurate joints). Large type protractor. Fixed to board are certain instruments.

Instruments mounted on board.

Ballistic calculator, converting map range to range corrected for barometer, air temperature, fuze and shell employed.

Wind corrector, giving line correction, and correcting range obtained from ballistic corrector.

Angle of sight calculator.

Clock code corrector.

Probability calculator.

* An instrument for this task has been issued for trial for 60-pdrs., but personally I am opposed to it because it is difficult to manipulate, and it is indirect reading, chiefly due to too many operations being performed on the same instrument. I mention this in case any users of the above who do not view it favorably should have prejudiced themselves against the idea of standard instruments.

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Detachable instruments encased on the board.

Clearance calculator.
Grid plotter.
High burst ranging corrector.

Refinements.

Small clock, with alarm attachment and separate hands for indicating 'zero time'.
Electric light, with standard battery and small rheostat.
Forms for recording details of each shoot.
Stand, case and spares.

OBSERVATION OFFICER'S INSTRUMENT.

Appearance—Folding map board with certain instruments.
Instruments—Grid Plotter.
Flank observation computor.
Luminous map reader.
Watch.
Eraseable writing tablet (luminous at night).

SECTION COMMANDER'S INSTRUMENT.

Appearance—Small board.
Instruments—Concentration calculator, etc.
Tablet with extracts from range table (to simplify checking).
Watch.
Eraseable writing tablet (luminous for night work).

NUMBERS ONES INSTRUMENT.

Ballistic calculator for M.V. and charge temperature.
Watch.
Eraseable writing tablet.

Such a set of instruments could be reduced or augmented to any desired standard. For howitzers, the set would require more complicated instruments.

ARTILLERY INSTRUMENTS MENTIONED IN THE ARTICLE.

Name.	Fig.	Obtainable from*.
Ballistic correctors:—		
Atmospheric slide rule	7	Any firm.
Clock code:—		
Auto corrector	4A	A
Indicator	9	A & C
Translator	5	B
Map clock	6	Any firm.
Compasses:—		
Creagh Osborne	3 and 4	B
Lensatic	2	C
Steward	1	A

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Crest clearance :—		
Contour type	—	—
Jennings	—	—
Kennedy	—	—
Displacement corrector	—	Can be made locally.
Flank observation :—		
Notcutt	—	A
Grid plotter	—	Service issue.
Night instruments :—		
Map reader	17	B
Luminous tablet	16	A
Nomograms :—		
Angle of sight etc.		Can be copied from articles in R.A. Journal.
Flank observation		
Wind		
Plotter (Oke-Steward)	12	A
Pocket map board	18	D
Protractors :—		
Sector	9	Any firm.
'Artillery'	10	A&B (type in Fig. 10 from C)
Eton scale	11	A
Range tape	8	A
Slide rule	—	Any firm.
Telescope (Davon)	15	D
Wind correctors :—		
Aslett	—	Variation of design from B.
Dennis	—	—
Down	—	—
Kennedy	—	Can be made locally.
Layton	14	A
Mallinson	—	A
Norsworthy	—	—
Notcutt (Gun type)	13	A
Oke	—	A omitted but is of class I type.
Richardson	—	Can be made locally.

*LIST OF FIRMS QUOTED ABOVE.

A = Messrs. J. H. Steward, Ltd., 406, Strand.

B = Messrs Henry Hughes, Ltd., 59, Fenchurch St., E.C. 3.

C = Messrs. Negretti & Zambra, Ltd., 39, Holborn Viaduct, E.C.

D = Messrs. F. Davidson & Co., Ltd., 29, Gt. Portland St., W.

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REMARKS ON TRENCH ARTILLERY

From the United States "Field Artillery Journal".
January—March, 1918.

AS indicated by its name, trench artillery is an auxiliary and special artillery employed in the most advanced position, and particularly as an offensive weapon. It is the economical heavy artillery, which is easily moved in the trenches and whose projectiles are, above all, explosive carriers.

In its employment it does not take the place of the field artillery or of the ordinary heavy artillery. Many targets cannot be reached effectively by the field artillery, because they are greatly defiladed or strongly entrenched. On the other hand, because of the men, horses, and ammunition necessary, heavy artillery is very expensive.

The most characteristic feature of trench artillery is its ability to fire from any position and under circumstances where it would be impossible for other artillery "to live"; trench artillery can live and be effective because of its ability to establish itself in any trench or similar excavation. Its powerful effectiveness has rendered its employment indispensable, and, owing to its vertical fire, any target within its range can be reached; both in the calm sectors as well as the fiercest combat trench artillery takes an important part in modern warfare.

With the exception of a few German *minenwerfer* designed several years before the outbreak of the hostilities, trench mortars have never been made or employed before the present war, and hence it will not take long to tell their story.

As a matter of fact, these *minenwerfer* were intended for use only in siege warfare. The extensive entrenchment after the battle of the Marne gave them their initial opportunity. The Allies had, therefore, perforce to adjust themselves rapidly to the new conditions of war, to build a similar material, simple, solid, compact, as light as possible, easily moved over an upturned terrain, and of effective action against the *minenwerfer*. To be sure, makeshift devices were employed at first, but now such mortars and bombs can be reguarded only as "curios" or "antiques."

At the same time appeared bristling along the front a most formidable means of defence—the wire entanglements. Their destruction was the fundamental preliminary to the success of any attack by the infantry. At first the brave engineers were forced to creep up to the entanglements and destroy them with charges of explosives.

Then some engineer officers hit upon the idea of the explosive charge to the end of a rocket-rod which was thrown by hand and

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reached only a distance of thirty or forty yards. Subsequently they succeeded in propelling the explosive from a 75-cartridge case employed as a gun. As such a device was useless after each shot, they decided to employ it as a projectile; for this purpose they placed a 75-cartridge case containing two charges of explosive and the propelling black powder on a wooden mandrel which served to give the angle of fire. This rudimentary projectile was improved by welding three vanes to it, which gave it a more regular trajectory. All these experiments took place in the front-line trenches. There were evolved the first lineaments of the modern bomb, which opened the way whereby the trench artillerymen met with entire success and won considerable honor and glory.

Since that time, on both sides of No Man's Land, many models of trench mortars have been built and used, each new type bringing with it a new improvement, but retaining the facility of manipulation as the most important quality; at the same time, both the accuracy in firing and the range were increased. During this process many types were rejected; by the selection of only the best the first batteries of trench artillery were formed. The initial scheme was to use these mortars as "accompanying artillery." This employment has since been abandoned. Subsequently, the trench artillery was divided into three types—light, medium, and heavy. The light type is employed only by infantry; the medium and heavy types are served by the artillery.

But, since the present war requires a constant adaptation to new conditions of battle, the models to be employed seem at present to tend once more toward a multiplication of devices in order that each new type may fit more thoroughly the special conditions required. It would be foreign to the purpose of this article to review the different models now in use at the front; it would be sufficient here to indicate the most important characteristics of trench mortars.

Let us glance rapidly at the light material employed by the infantry. The mortars must be light—that is, susceptible of being carried by only one man; owing to the necessity of firing from any part of the trenches, they must not require special installation, thus avoiding discovery by the enemy due to the possibility of frequent removal. The most important qualities are a great accuracy and a great rapidity in firing.

From the front-line trenches the presence of the enemy is disclosed by very slight tokens which very often are not noticeable from the artillery observation posts. Furthermore, there are but few men in the front lines, and thus it is not always advisable to waste the projectiles of field artillery in firing at worthless objectives.

The objectives which are most frequently attacked by this type of mortars are: Fatigue parties bearing water, food, and ammunition passing through the communication trenches or in the vicinity of commanding posts; the telephone operators verifying or repairing the wires; soldiers working for the maintenance of the trenches, etc., visible only for a short time, and hence it will readily appear that the fire must be rapid and accurate in order to secure effective shots before the enemy is sheltered.

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Since the employment of this material does not require a long range, due to the small extent of the enemy's trenches visible from our own front lines, it is possible to make use of very simple mortars which are very accurate in fire. The projectile desirable for this purpose is one nearly as powerful as the high-explosive shell of 75 mm. Valuable use of such mortars is in firing repeatedly around and at the place of a work already destroyed by the heavy artillery in order to prevent the enemy from rebuilding it.

In the same class of material can be placed the grenade throwers, which employ grenades for analogous purposes.

Enough, however, regarding these small-hit useful mortars. Let us now consider the more powerful materials of medium and heavy type.

The most important characteristics of these mortars is that they may be taken down rapidly in order to facititate their transportation. This condition is fulfilled when their heaviest part can be transported by two men in the case of medium and by a *one-horse voiturette* in the case of heavy mortars. It has been shown by experience that the heaviest part of each mortar should not exceed 160 pounds for the medium type and 850 pounds for the heavy type.

Trench mortars are generally built for vertical firing, and hence it has been found advisable to mount them by means of trunnions placed near the breech. A few of the latest types are furnished with a buffer, but more generally the carriage is placed on a platform. This question of the platform must be considered with great care, and, indeed, the *reactions* from the ground must interfere neither with the projectile nor with the mortar. Therefore the weight and the bearing surface of the platform must be sufficient, even though these conditions are contrary to the first quality desired in a mortar; namely, its faculty of being easily transported. Moreover, especially in the case of heavy mortars when an important operation is in preparation requiring a considerable number of shots, the platform is placed on a solid foundation made of quick-setting cement.

As stated at the beginning of these remarks, the trench mortars are the economical heavy artillery; this is obvious if we consider that generally trench mortars have no rifling, the projectiles being stabilized by means of vanes. Consequently the power of the powder is employed only in propelling the projectile, whereas in the ordinary heavy artillery a considerable part of this power is employed in forcing the projectile to take the grooves and in imparting to it the rotating motion, so that if we compare a projectile of heavy artillery with a projectile of trench artillery of the same weight and thrown to the same distance the necessary amount of propelling powder is smaller for trench artillery. In consequence of a lower internal pressure the mortar may be made lighter and so it appears clearly that, as regards the cost of the material and the expense for the propelling charge, the trench artillery is the economical heavy artillery.

The vaned bomb which contributes so much to this economical character is, above all, an explosive carrier. In this respect, for instance, the best type employed in the French Army is the 240-mm

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bomb, which weighs about 190 pounds and contains about 100 pounds of explosive (this is over 50 per cent. of the total weight); whereas in heavy artillery the 155-mm. shell weighs 94·6 pounds and contains 22·44 pounds of explosive (this is about 24 per cent. of the total weight).

Since the internal pressure in the mortar is low, the bomb is not submitted to great stresses, and consequently its manufacture does not demand so high a quality as the shells of heavy artillery. The bombs are made in order to have the greatest possible internal capacity for containing the greatest amount of explosive.

The explosives employed are particularly the chlorated or perchlorated explosives, because of their great effectiveness in upturning the ground. Thus we may say that if the amount of ground upturned by a given volume of picric acid is 10, then the amount of ground upturned by an equal volume of chlorated explosive would reach 16. Moreover, due to the fact that the muzzle velocity in the case of the trench mortar is not considerable, the chlorated explosive can resist the shock on firing. However, the explosive must be strongly compressed in order to avoid premature explosions, because of the friction of the explosive sliding by its inertia along the walls of the bomb—just as the friction of a rifle bullet produces an explosion of a bomb after piercing its walls.

The bombs are primed with different types of fuzes, according to the effect to be produced: with instantaneous fuzes when firing against personnel or wire entanglements, and with fuzes with delayed action for destroying shelters, dugouts, etc. But these fuzes must be especially built to arm themselves, even with the small initial velocity of the bombs.

The effectiveness of the bomb is easily shown by the craters formed in the ground, which have a diameter of 12 feet and a depth of about 4 or 5 feet for the medium mortars. The craters formed by the bombs of 240 mm. have a diameter reaching 30 feet and a depth reaching 10 or 12 feet.

When employed for destroying the wire entanglements, the medium bombs can clean an area from 200 to 400 square feet. In fire against personnel the fragments of the medium bomb are dangerous at a distance of 500 yards from the point of impact.

When employed for filling up the trenches, we may consider that a medium bomb falling within one-half yard from the parapet can fill the trench for a length of 4 yards, and a bomb of 240 mm. falling within 2 yards from the parapet can fill up the trench for a length of about 10 yards.

It may seem somewhat difficult to obtain good results with trench mortars which have a considerable "probable error," but in a practical way we should not calculate this "probable error" as a percentage of the range. We must consider only the extent of this error in comparison with the extent of the error in the fire of heavy artillery. For instance, for the 240-mm. the "zone of dispersion" is about 160 yards long and 80 yards wide, whereas for the 155-mm. gun the zone of dispersion is about 270 yards long and 25 yards wide. The advantage of the heavy artillery is not considerable, and, more-

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over, it seems possible to increase largely the accuracy of trench artillery.

The adjustment of the fire of a trench battery is not always an easy matter, the targets being generally very difficult to distinguish, so that it is often advisable to have an observation post behind the battery with a command of the terrain for adjusting the direction and an advanced post for adjusting the range. But in an advanced post the observation is somewhat dangerous from the very explosion which is to be observed. Two kinds of fragments may be of danger for an advanced observer: the ones projected in the air, which fall nearly vertical to the ground; these are not especially to be feared because it is easy to be protected by a slight shelter. But the fragments projected by the explosion parallel to the ground are especially dangerous, because they may attain a velocity of over 3000 feet per second. Thus one cannot think of observing an explosion and of sheltering one's self afterward, because of the great risk of being hit by a fragment before it is possible to take shelter.

The method of attacking the different targets may be resumed in a few words. When the destruction of trenches is desired it is obvious that the best results are obtained by *enfilade* fire rather than by firing in a direction perpendicular to the trench. On the contrary, for the destruction of "wire entanglements," due to the necessity of obtaining a way cleared through the entanglement, it is better to fire in a direction perpendicular to this entanglement.

It is to be remembered here that trench artillery is an auxiliary artillery, and that each time an important bombardment by trench artillery is in preparation the simultaneous employment of field and heavy artillery is to be provided, especially at the time when the fire for effect is to be carried out. They should have co-operation of field and heavy artillery to distract the attention of the enemy, so that the opposite observers may not have the opportunity of noting carefully the places whence the bombs are fired. This collaboration may be outlined thus: The field artillery opens fire against the enemy's trenches, directing the shells especially at the points where the observation posts are supposed to be; the occupants of the shelter then are no longer able to observe carefully, and may be even prevented absolutely from observing at all. Then the trench artillery opens fire as quickly as possible, and meanwhile the heavy artillery keeps itself in readiness to attack the enemy's heavy artillery which would attempt to destroy our own trench mortars.

As soon as a definite task has been intrusted to a trench battery the commanding officer of the battery has at first to determine the number of mortars to be employed and their position. In view of this, he begins by studying the map, the sizes of the objectives, their distance from the zone to be occupied, and fixes the space in which the positions can be selected. Thereupon he can determine the number of mortars which are to be fired at each target; this number is determined according to the time within which the task can be accomplished.

Then the commanding officer proceeds to a rapid reconnaissance of the ground, whereupon he goes over the same ground again with

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his lieutenants and gives them general instructions regarding the position of the battery, but lets them choose the exact position of each mortar in a narrow zone previously appointed by him for each one; finally he gives his approval to the position chosen by his lieutenants.

A few principles are to be kept in mind in fixing the positions:

(a) For destroying trenches, enfiladed fire is better.

(b) For destroying wire entanglements a trajectory perpendicular to the entanglement is to be employed.

(c) For firing at a small target with a great number of mortars it is more convenient to have a concentration of fire from scattered mortars than to gather numerous mortars in a small sector; the installation is easier, less vulnerable, and the enemy's observation made more difficult.

(d) Positions are to be avoided in the vicinity of commanding posts, central stations of telephone strongholds, shelters for reserve troops, etc.

(e) So far as possible, the battery should be protected from the enemy's sight; however, it is not advisable to place the mortars behind an isolated wall, a bush, a tree, a hedge, an embankment, or, in general, behind anything noticeable silhouetted on the landscape, the protection offered by these points being of quite an illusory character, because they make easier for the enemy the adjusting of fire.

Moreover, it is advisable to prepare a few more positions of mortars than are strictly necessary, and, on the other hand, no position is to be definitely chosen before being approved by the commanding officer of the infantry of the sector.

The organization of the position then takes place. Sometimes trench mortars are designed for vertical firing; the positions are to be organized accordingly. The mortars can be placed in deep craters or special trenches so that they are properly protected from view even if the terrain itself presents no satisfactory shelter. The depth of the platform is limited only by the dimensions of the pit from which the bombs are fired; the length and width of this pit are generally equal to the depth.

Owing to the possibility of premature explosions, special care is to be taken in the disposition of the mortar. Each mortar position must be prepared with two escape-trenches provided with *traverses* which allow a rapid evacuation from the mortar position by the gunners, and minimize the results of an accident. However summary the first installation of the battery may be, a definite plan should at least be determined on regarding the cover and with a view to further improvements.

For each mortar we have to prepare, on the position itself, an entrenchment for the mortar, a dugout for the artillerymen, and a few shelters for ammunition; at some distance behind the battery, intermediary depots for bombs, and, if possible, good shelters for gunners, in which they can rest between the rounds of fire and take shelter against bombardments.

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When preparing the position it is of great importance to avoid regular outline or geometrical lines which are noticed from airplanes. The most careful camouflage should be employed.

At present the most satisfactory medium material for trench artillery must be able to throw from 300 to 2300 yards a projectile containing at least 8 pounds of explosive; it must be readily movable and easily installed.

The most considerable difficulty is to supply the battery with a sufficient amount of bombs, especially in the front lines. That is the reason why we require a range of about 2300 yards thus enabling the trench batteries "to live" at a short distance behind the front line. That is why we require greater accuracy in firing; namely, because it enables the trench mortars to attain the maximum results with the minimum expense of ammunition.

The Economic Effort of the Central Empires.

Translated from "L'Europe Nouvelle," 24 August, 1918.

Communicated by

Temp. Major F. M. G. Du Plat-Taylor, R.G.A.

The development of railway lines during 1916.

The German Reviews give some interesting details of the new means of communication constructed to meet the present military and economic requirements of Germany, Austria, Bulgaria and Turkey. Most of these lines, of purely strategic utility, will not survive, but some of them have not this temporary character, and, born of the War, will subsist in time of peace.

Such are the great lines of "penetration" towards Russia. Amongst these which have been constructed during 1916 we may mention the line Bajohren—Prekulm which now forms the most direct means of communication with Libau, and the line Lauzargen—Tauroggen—Schaulen which improves the connection between Tilsit and Mittau.

In Servia the railway has been re-established over the Danube to Belgrade and Semendria. A new bridge has been thrown over the Danube at Bazias to connect up the Hungarian route, Temesvar—Bazias, with Servia and Bulgaria.

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A new line has been built to exploit the Servian lead at Babaic, by means of which 100 wagons of lead ore and one of pure lead can be transported daily.

The most interesting enterprise perhaps, from the economic point of view, is the towing railway constructed on the Servian bank of the Danube near the Iron Gates with the object of facilitating the transport of boats loaded with Roumanian grains through the rapids. Up to now, in spite of all the improvements made, the most powerful tugs on the Danube could only tow one vessel at a time through the canal laid out through the rapids; and this occupied 1¼ hours. To-day, owing to the new system of haulage by railway, two steamers can traverse the rapids in 21 minutes. Barely 6 or 8 tugs formerly daily traversed the Iron Gates, but to-day 30 or 40 vessels pass each day conveying grain, the quantity of which conveyed has risen from 400 to 2000 wagon loads.

As for Bulgaria, she has succeeded, thanks to the defeat of Roumania, in realising her project of a bridge over the Danube at Sistova. Further, she is proceeding with the nationalisation of the whole of her railway system, including the lines Ferré—Oksillar and Ferré—Dedeagatch, which form a part of the line from Salonica to Constantinople and are French property.

We must also notice the project adopted by the Sobranje of a railway line connecting the Danube and Egean; which will start no doubt from Porto-Lagos (on the Sofia-Adrianople line) and join on to the Rustchuk-Tirnova-Stara Zagora railway.

Finally in Turkey there is the new line of 400 kilometres (248 miles) which connects the Bosphorus with coal bearing basin of Heracleia, on the Southern shore of the Black Sea, and has been constructed with the object of assuring the supply of coal to Constantinople in the event of the sea route being interrupted by the operations of war.

24th August, 1918.

The above notes, translated from a French review, have some interest, in showing that the economic development of the Central Powers has, as in this country, received a stimulus owing to the War, no doubt as far as the Balkan States are concerned, largely owing to German financial assistance. The railway and other improvements made on the Danube will, it is to be hoped soon prove a permanent benefit to Servia and Roumania.

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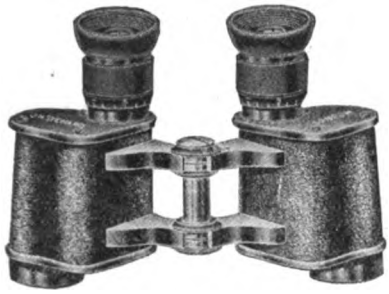

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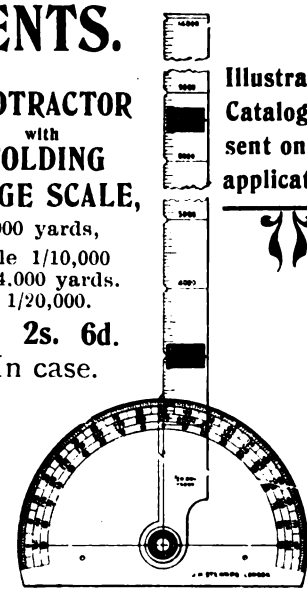

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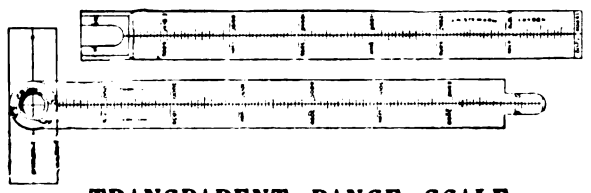

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Woolwich,
July, 1918.

J. E. H. Orr, Captain,
Secretary.

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Contents of R.A. Journal, November, 1918.

The Journal of the Royal Artillery 253

Actions Performed by the Artillery of the Fifth Army. By Major-Genl. H. C. C. Uniacke, C.B., C.M.G. 255

A Simple Apparatus for Instructing Gunlayers. By Capt. R. V. Walling, R.G.A. (T.). 283

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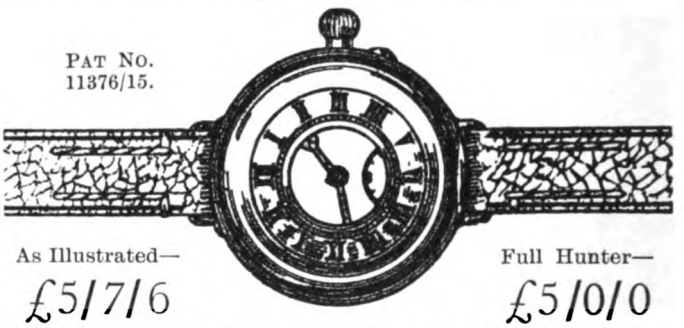

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THE JOURNAL OF THE ROYAL ARTILLERY.

May I, as Vice-President of the R.A.I. Committee, appeal to the Regiment at large for help.

Month by month we are more and more pressed to find matter for publication in the *Journal of the Royal Artillery*. Articles sent for publication become fewer, and more and more abstruse. Truly, the primary object of the Royal Artillery Journal is educational, and for that purpose a grant is given from public funds, but it seems to me that the officers of the Regiment construe the word "educational" in its narrowest form, and, unless they have some abstruse problem to ventilate or some calculation of x to put forward, are chary of sending up anything for review and publication.

Education to my mind includes all experiences of every sort, and a short and well written account of sport; a hunt; a "shoot"; exploration in the wilds; any experience in civil life and trade; and above all the doings of individual batteries and sections in action in various parts of the fighting front in this War; or reminiscences of personal experiences with guns, rifles, or the "Arme Blanche" in other wars; are all of the highest educational value, just as valuable as the most wonderful gymnastic performance of x and its allies that ever confronted the horrified layman on opening the familiar yellow cover.

Now, from a strength of some 2,500 odd officers we have grown to 28,000, surely it is not seemly that the old Royal Artillery Journal should shrink in volume, surely it should expand and become a most valuable and *readable* magazine. The thousands of officers from every trade in life that now have the honour to belong to the Artillery, have nearly all of them unique experiences to tell if they could only be persuaded to jot down on paper one or two items from their adventurous life, just think what a mine of readable and educational wealth that would open for the old Royal Artillery Journal.

In my own small experience since the war began I have had officers serving under me who were planters in Ceylon and India, tin miners in the Malay States, sheep farmers in Patagonia, managers of estates in Australia, America,

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Canada, Africa and Asia, miners in every part of the world, engineers of all sorts and kinds who have lived in every part of the globe, habitable and otherwise. What experiences they must have had! and just think of what educational value such experiences would be to their brother officers and men if they could only be persuaded to put pen to paper and detail them. We live a strenuous life now-a-days, leisure as we knew it before the war is not now existent, and, to the bulk of our fellows, life is precarious and there are many and fearsome interruptions to a literary career, but still there are periods—even in an "O. Pip"—when time is apt to hang heavily on our hands, "nothing doing" and the Bosche invisible and quiescent. Can we not appeal to our brother officers that, in such periods of comparative peace and boredom, they should give a thought to the old "Royal Artillery Journal" and jot down a short, article, reminiscent of more peaceful pursuits, even if it drew aside for a moment the veil spread over a lurid and purple past.

When the war is over there will be a good sorting out, thousands of officers who, to their great and everlasting honour, chucked a sure career, will be seeking again to make good for themselves. In many cases their old trades will be overstocked, and they will have to start a new one. In others the old trade and routine will have become unbearable and a freer life a necessity. For all such I appeal to their brother officers. An article from a man who, himself, has "been there" is of far more educational value to the seekers after new careers than oceans of government publications backed by endless arid vistas of statistics. The human touch is in such an article; the difficulties and snags, the loneliness and depression, are all set out and also, on the other side, the various and varied compensations. Many a man I have met has settled his career on the strength of a magazine article and few of these have regretted it. Can we not appeal to our officers to do all they can to enable the old Royal Artillery Journal to take rank among other magazines as a helpful finder of careers?

R. W. BREEKS,
Brig.-Genl.

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ACTIONS PERFORMED BY THE ARTILLERY OF THE FIFTH ARMY.

By Major Genl. H. C. C. Uniacke, C.B., C.M.G.

The following extracts from Corps and Divisional reports on the operations which commenced on 21st March, 1918, form a fitting sequel to the many gallant deeds, in this and former wars, which have added lustre to the history and made the traditions of the Royal Regiment of Artillery.

It is known that for each recorded incident many deeds of equal gallantry and devotion to duty have been left unrecorded; Commanders have in many cases been continuously engaged and have had no time to make the record. It is certain that many a heroic episode passed unnoticed.

The continuous physical strain required of all Artillery personnel and the need for initiative, resource and quick decision in subordinate Commanders during this period are only comparable to conditions obtaining in the early weeks of the war. It must be remembered however, that the Artillery of the original Expeditionary Force came prepared by years of training in the principles of open warfare and fresh from the practice camps of 1914, whereas the gunner of to-day has had but little training in and no experience of open warfare; his short rest periods have of necessity been spent in elementary training of reinforcements, technical instruction of specialists and such exercises as the stagnant conditions of trench warfare demanded; indirect laying, permanent communications, prepared positions, and programme shoots were his creed and would have been the undoing of personnel less adaptable.

The rest periods of Heavy and Siege Units have been still more infrequent than those of the Field Artillery, and conquently have been almost entirely devoted to resting the personnel and "getting the Battery together". It is unfortunate that further records of their gallant actions are not available but it is known that they adapted themselves to the requirements of open warfare mobility and direct laying with a facility equal to that of the Field Artillery, cases are on record of close co-operation between 9·2″ Howitzers and machine guns firing side by side over open sights: of the Infantry retiring behind 9·2″ Batteries which continued in action long afterwards, until dismantled and withdrawn under cover of their own Lewis Guns. When a gap was left in the flank of XIX Corps, it was six Heavy and Siege Batteries which stopped the gap without assistance for some hours until troops could be rushed up to fill the gap.

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Personnel whose guns had either been destroyed or abandoned owing to destruction of teams or absence of the neccessary Mechanical transport fought on under their own officers with salved rifles and ammunition.

A side-light from the report of the 16th Divisional Artillery of the working of Ordnance Workshops during this period is worthy of record. "O.C." 180th Brigade R.F.A. reported that Lieut.—— had made a personal reconnaissance at this time (March 22nd) through Marquai and thence towards the Ridge North and N.E. of Roisel which he found held by the enemy. The country between was practically deserted except for the I.O.M. at Hamel who had some guns in the workshops there. These (3-18-pdrs.) were removed by the 180th Brigade, R.F.A. during the night and the I.O.M. withdrew having seen the last gun away from his Shops".

Royal Horse Artillery.

"C" Battery R.H.A. on April 4th, though it was at one time reduced to 1 officer and 14 other ranks, continued to work all their guns.

The 3rd Brigade R.H.A. (D E & J Batteries) in support of the 2nd Cavalry Division on April 1st, by making full use of their mobility combined with a bold policy, accounted for a very large number of the enemy and very materially assisted in the success of the operation.

"G" Battery R.H.A. on the 23rd March continued to fire for 20 minutes after the infantry had retired through the guns to a crest 500 yards in rear of the Battery position. The Officer Commanding came under heavy Machine Gun fire in the O.P. and never rejoined the Battery. An Infantry Officer reported that he fell in leading a charge against the enemy at the head of a body of Infantry that he had rallied and collected.

"H" Battery R.H.A. on March 22nd fired 1000 rounds at close range into the Germans over the open sights as they advanced down the slopes from Hesbecourt.

"I" Battery R.H.A. on March 28th remained in action until our Infantry were close to the guns; the Battery was then withdrawn, leaving one section which continued to fire with great execution until ordered to rejoin the battery.

"Y" Battery R.H.A. on March 27th quickly ranged on an enemy battery that had come into action on the crest South of Morlancourt, and prevented it from firing all day. Teams and detachments were scattered and driven from the position several times when trying to approach the guns.

Royal Field Artillery.

14th Division.

Several batteries sent out patrols, but these never returned. The great use of the Lewis Guns with batteries was brought out, with these and their rifles the Huns were kept off for some time until batteries were surrounded. In most instances a large part of the

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personnel broke their way through and joined up with small parties of Infantry in strong points and trenches where they fought as Infantry. In two cases the Huns advanced against batteries with their hands up and then laid down and opened fire at short range. In two known cases the Huns immediately blew up the guns when they had got to them.

March 21st.

C/47 Brigade R.F.A. were captured. Everybody was taken prisoner and ordered to go back to the German rear. On the way back they heard B/47th Brigade R.F.A. still firing, so circled round in the fog and joined "B" Battery without any trouble.

After they had lost their guns, the officers and men of the 47th Brigade R.F.A. helped to man the trenches with the Infantry and assisted in collecting Infantry stragglers and organising them into formed bodies of men.

16th Divisional Artillery.

107th and 180th Brigades, with the 277th Army Brigade, R.F.A.

These few instances of gallantry and devotion to duty form but a few of the many gallant deeds performed by batteries and individuals of 16th Divisional Artillery. Many of the latter have been sent forward for immediate reward but far more have unfortunately passed unnoticed.

21st March.

O.C., 180th Brigade R.F.A. reported that C/180 Battery had had 4 guns out of 5 destroyed by shell fire but were keeping up fire with the remaining gun and with the gunners organised as riflemen by Major ——.

At this time a Machine Gun was firing into the battery from the rear. Major —— thinking it was one of our own Machine Guns the Battery Commander sent out an orderly to tell the men manning it that they were shooting into his battery. The orderly did not return so he went himself and discovered it was an enemy Machine Gun.

This Battery (C/180) fought most gallantly under Major —— until the late afternoon.

The last remaining gun was fought until it also was destroyed by shell fire, the personnel of the battery then fought their way back to the next line with their rifles.

When the enemy appeared with machine guns on the right flank of D/177 battery, 2nd Lieut. —— was in command. In order to bring more effective fire to bear he ran one of his howitzers out of the protection of its pit into the open and having done so, he himself manned a Lewis Gun and inflicted many casualties on the advancing Germans—not until the enemy got within 100 yards of the guns did he give the order to withdraw, he himself by then being seriously wounded. The men withdrew with their sights and breech blocks, and some gunners returned to take away their

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wounded officer. But this he would not allow them to do, ordering them to get away themselves and join the Infantry in manning a trench in rear.

C/177 battery brought up the gun limbers to withdraw the guns. The limbers came up steadily under heavy Artillery fire. They had to pass through a narrow gap in thick wire which was swept by machine gun fire. Team after team advanced steadily to the gap, but few men or horses got right through. The few that did, went on under incessant machine gun and rifle fire. Many horses were shot down, and out of the 18 gun drivers, 11 were killed and 6 wounded. 1 only was untouched, and he is still with the battery.

D/177 Battery also made a gallant attempt to get away their guns. Again a gap in the wire swept by machine guns had to be negotiated. 7 of the 18 drivers and many horses fell in the attempt. When 2nd Lieut. —— arrived at the gun position with the survivors he found the Germans already in occupation. The teams of C/180 under 2nd Lieut. —— (since killed) after heavy casualties got close up to the guns, but they too found the enemy already in the battery position, the gunners having withdrawn as the guns had been destroyed by shell fire.

In C/177 Battery, the Battery Commander was wounded, but the battery fought their guns over the open sights until the Germans were within 200 yards. The gunners then withdrew quietly and in order under 2nd Lieut. —— taking their sights and breech blocks, and joined the Infantry holding the road in rear. 2nd Lieut. —— although badly wounded, refused to leave his men. He was carried away shortly afterwards, having fainted from loss of blood.

The above are a few instances as to how the 177th and 180th Brigades R.F.A. of the 16th Divisional Artillery, commanded by Lt.-Col. ——, and Major —— fought their guns on that day.

27th March.

The 177th Brigade R.F.A. having been re-equipped with guns, took their place in the line once more.

A/177th Battery under Lieut. —— was ordered to move forward to the ridge just West of Proyart with orders to remain there until the enemy advanced and not to retire until their ammunition was expended.

This battery only came away when taken in enfilade, by hostile guns from the North when it retired to another position on the ridge further West.

Later, when the enemy continued to advance on the left flank, it retired steadily and in good order, taking up two more positions on the way to La Motte.

B, C and D/177 batteries covered the retirement of the Infantry on the same principle, all firing with good effect on the advancing enemy on many occasions.

These batteries were handled with great skill and boldness by their Battery Commanders and inflicted very heavy casualties on the enemy.

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The Batteries of the 180th and 277th Brigades R.F.A. acted in a similar manner, but unfortunately no actual details of their performances are forthcoming.

B/177 Battery had a duel in the open with a German battery, which it completely knocked out.

As bad luck would have it, just as they got into action, a hostile battery firing in enfilade from North of the river opened on them causing casualties in all the gun teams.

Although the battery (B/177th) could not be maintained in that position, Major ——, the Battery Commander, with great gallantry and presence of mind, stopped and collected the stampeded teams and succeeded in saving all his guns.

He then brought his battery into action without delay in a position on the ridge behind, and remained there throughout the day until he eventually took up a position West of La Motte.

When night came on, this battery had only 6 gunners left with the gun line who were capable of working the guns.

4th April.

O.C. B/177th Battery seeing large bodies of the enemy which he was unable to deal with effectively from the Battery position ordered his guns up to the crest where 90 rounds per gun were fired. The Battery having completely broken up the enemy attack then withdrew to its original position. The same battery only a few days previously had suffered so heavily from enfilade Artillery and Machine Gun fire in carrying out a similar operation that only six gunners were left who were capable of working the guns.

At 1.35 p.m. A/180 Battery in the open was so neutralized by hostile fire that it could not bring effective fire to bear.

The guns were therefore withdrawn to a position under cover. This was no easy task owing to the intensity of the enemy's hostile Artillery fire. One gun had to be temporarily left behind as the team coming up for it was destroyed, but the gun was withdrawn as soon as another team could be brought up.

During this period great risks had to be taken and time after time guns were kept in action with no other troops whatsoever between them and the enemy. That no guns were lost was due to the coolness, judgment and fine soldierly qualities displayed by the Battery and Section Commanders who in most cases had to act on their own initiative according to the circumstances at the moment.

The strain on officers and men, who for the previous 15 days had marched and fought without cessation, exposed throughout the day to Heavy Artillery, Machine Gun and rifle fire, was very great. All ranks, however, though tired and worn out and very short of sleep, responded nobly to the urgent call made upon them. Their behaviour was magnificent, the one idea of all being to hold the line whatever happened.

The batteries were fighting with very reduced strengths. Several Battery Commanders and many officers, N.C.O's. and men had fallen during the previous fortnight, but this in no way interfered with the efficient working of the guns.

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The behaviour of these New Army batteries was in keeping with the very best traditions of the Regiment.

Artillery Observers, corroborated by those of the Cavalry and Infantry, are agreed that attacks were on many occasions hurled back by Artillery fire alone and very severe punishment inflicted on the enemy.

These actions entailed a very large expenditure of ammunition causing some anxiety from time to time, but this was only temporary and at no time was there any shortage, or the supply not up to requirements. This was due to the excellent work of the 16th D.A.C. which supplied ammunition to the batteries throughout the day along shell swept roads and tracks.

The following extract is taken from the 19th Corps Report of the action on 27th March:—

> "The batteries of the 16th D.A. were handled with great skill and boldness. The situation was made difficult by being overlooked from the high ground North of the Somme. Many targets were engaged over open sights, and the guns were kept in action when no other troops remained between them and the enemy."

18th Divisional Artillery.

82nd and 83rd Brigades, R.F.A.

A/82nd Brigade, R.F.A.

On the 21st March this battery was in action up till 5 p.m. about 1000 yards West of Fort Venduil. From 12 noon to 2.45 p.m. they engaged the enemy in large numbers in front of the wire of the Ly-Fontaine—Venduil switch line which was about 300 yards from the guns, and inflicted very heavy casualties.

About 3.45 p.m. Capt. —— sent a message by runner giving the above information and asking for assistance, as the enemy had worked up close and were sniping the gunners on the guns. Shortly afterwards Capt. —— was hit by a sniper and believed to be killed. 2nd Lieut —— took command, and sent a runner back to the nearest Infantry post with a message that he would hold out to the last. The runner, however, lost his way and the position was rushed by the enemy about 5 p.m. when all the survivors were captured.

B/82nd Brigade R.F.A.

On 21st March a forward section of this battery was in action 500 yards South of A/82nd Brigade's position, commanded by 2nd Lieut. ——, who was ably seconded by 2nd Lieut. ——. This section remained in action all day, although the enemy had got round both flanks. At 1.30 p.m. they engaged the enemy South of Venduil Fort with open sights, and from then till 6 p.m., 800 rounds were fired at the enemy Infantry at very short range.

At 5 p.m., when A/82nd Brigade's position was captured, this section turned on to the enemy in that locality and fired 100 rounds.

At dusk the guns were destroyed and the detachments were successfully withdrawn.

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O.C. B/82nd Brigade, after visiting this advanced section at 2 p.m. returned to his Battle Zone O.P. and directed the fire of his rear guns and other batteries of the Brigade on to hostile Infantry advancing over the crest South of Venduil, and delayed their advance sufficiently to allow other advanced posts to withdraw at dusk.

C/83rd Brigade R.F.A.

On 21st March this battery was in action in three dispersed section positions South East and South of Benay.

The most forward section was rushed by the enemy in the mist at about 11.15 a.m. Captain —— removed the breech blocks and withdrew his detachments fighting with their rifles to the next section position, but before these two guns could be fired, the enemy were found to be right upon this position, also, advancing from the North. Breech blocks were again removed and detachments withdrawn to a sunken road which was defended for an hour with rifles and a machine gun which had been picked up. Meanwhile communication was opened to the rear section by telephone, and its fire directed with very great effect, silencing several M.G's. and inflicting heavy casualties on the enemy

This position was held till 8 p.m. entirely by gun fire and repeated attempts of the enemy to rush it were beaten off. It was constantly under M.G. fire, rifle fire and was shelled by one of our captured guns. In all 1,900 rounds were fired by this section.

At 8 p.m. when only one gun remained in action, but jamming badly, Capt. —— organised his rifles under 2nd Lieut. —— and 2nd Lieut. ——, to cover his withdrawal, which was carried out successfully about 9 a.m., the covering party succeeding, during the withdrawal, in capturing an enemy M.G. and taking prisoner some German Infantry who had worked round behind the position.

D/83rd Brigade R.F.A.

On 21st March this battery had two sections forward in action East of Ly Fontaine and one section North of Ly Fontaine close to Brigade Headquarters.

The rear section suffered very heavily from the hostile preliminary bombardment, and the detachments were all casualties. 2nd Lieut. —— was sent back from the forward position to re-organise the rear position with fresh detachments from the wagon lines. Meanwhile the personnel of the 83rd Brigade Headquarters were lined up in a trench by Lt.-Col. —— and armed with rifles in order to protect the howitzers. By 12 noon the section was again engaging the enemy at 500 yards range, and finally at 200 yards range, the gunners having to crouch to avoid splinters flying back from their own shell. A hostile battery which attempted to come into action at 1,500 yards was at once engaged, its teams bolted and the guns were so badly knocked about that they never opened fire all day.

In spite of constant M.G. fire at close range, this section remained in action until 6 p.m. when their last remaining round was fired.

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The detachments remained with the howitzers until 11 p.m. in the hopes of getting more ammunition, or of at least being able to withdraw the howitzers, but the enemy by this time had worked right round the flanks of the position and the limbers were not allowed to go up. The howitzers were accordingly disabled and the detachments fought their way back to the nearest Infantry.

No. 2 Section D.A.C.

On the 23rd March, wagons of No. 2 Section, under Lieut. —— went up to supply batteries about Faillouel with ammunition. The enemy Infantry having advanced very rapidly unobserved, through woods, it became necessary to withdraw "Z" Battery R.H.A. and 402nd Battery of the Fifth Army Artillery Brigade. The wagons of No. 2 Section being close at hand, they were called on to bring out the guns which they did most successfully, under heavy hostile fire, afterwards returning and delivering their ammunition.

21st Divisional Artillery.

94th and 95th Brigades R.F.A.

March 21st.

The 16th Division had now occupied the Brown Line in rear of the gun positions of 94th Brigade R.F.A. and soon withdrew to the St Emilie defences. The batteries were, therefore, ordered to withdraw to selected positions in the neighbourhood of Caulcourt, where ammunition had previously been dumped and lines laid out. D/94th Brigade withdrew under heavy Machine Gun fire without the loss of a gun, covered by the fire of A/94th and C/94th. The teams of A/94th had unfortunately gone astray, as the officer in charge had been severely wounded and his instructions were misunderstood, so the detachments were withdrawn with sights and breech blocks. One gun was very gallantly saved by 2nd Lieut. —— just before the enemy's Infantry arrived in the position and 3 others had been badly damaged by shell fire so that only two good guns had to be left. C/94th Brigade which had been firing for 2½ hours over open sights and had covered the withdrawal of the remainder, then withdrew to Saulcourt without the loss of a gun, although under very heavy and accurate enfilade fire from a hostile battery on its flank. These withdrawals could not have been carried out so late in the day, had it not been that the flank formed by them, together with the fire of the guns over open sights, kept the area between the two railways clear of the enemy.

At 4 p.m. it was decided to withdraw to the Green Line, and Half Batteries of all Brigades were ordered to take up previously selected positions in support of this line while the remaining Half Batteries covered the withdrawal of the Infantry.

22nd March.

These half batteries fired on the enemy advancing from Saulcourt and Guyencourt, and good targets were engaged, but the line fell

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back more quickly than was anticipated, and some teams' did not arrive in time to extricate the guns. The guns were fought until the enemy was less than three hundred yards from them and an attempt was then made to man-handle them back but had to be abandoned, the detachments eventually withdrawing with the sights and breech blocks leaving three 18-pdrs. and 3 4.5″ Hows., and three damaged guns to the enemy. The remaining guns rejoined their batteries near Bussu and Aizecourt Le Haut.

25th March.

On this day three guns under Lieut. —— which had been drawn from the Ordnance Gun Park were coming up via Peronne to replace casualties in A/94th Brigade. When near Peronne he discovered that our own Infantry had withdrawn and saw lines of enemy Infantry advancing at close range. He at once brought his guns into action with open sights, fired all the ammunition in his limbers, doing considerable execution and got his guns away without mishap. He joined up with his battery during the night.

The following examples of individual resource and gallantry in the 21st Divisional Artillery have been specially noted by the Divisional Commander:—

C/94th Brigade R.F.A.

This O.C. commanded his Battery with the utmost skill, courage and devotion to duty throughout the entire operations. Near Epehy on the 21st March, although his right flank was uncovered by the retirement of the Infantry, and although subjected to direct M.G. fire from his right front, and enfilade fire from a hostile battery which had come into action on his right flank, he kept his battery in action for over two hours until ordered to withdraw. During all the time he kept up a steady rate of fire with a proportion of his guns on the barrage for the support of the Division, who were still holding out in Epehy, and with the remainder run out of their pits engaging the advancing Infantry on his right front with open sights, inflicting severe casualties and holding up their advance. The fact that he was ultimately able to withdraw all his guns under fire without loss reflects the greatest credit on his fine skill and example at the time, and also on the complete arrangements for withdrawal which he had made previously. On many subsequent occasions he occupied positions with the greatest skill and brought effective fire to bear on the advancing Infantry with great rapidity. He has showed untiring energy and complete disregard to danger or discomfort under the most trying conditions and has set a splendid example at all times to all under his command.

Lieutenant ——. A/94th Brigade R.F.A.

For most conspicuous initiative, gallantry and devotion to duty near Epehy on 21st March, 1918. He was in charge of a forward gun, placed outside a Divisional front to cover the flank of Epehy, and maintained a steady rate of fire during the morning, though

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subjected to intense shelling with H.E. and gas. When the Division on our right lost Malassise Farm and Ronsoy and withdrew towards St. Emilie, he was left completely in the air. He continued to defend his front with gun fire, while he kept off enemy who were working round to his right rear by the rifle fire of his own detachments, himself taking his turn in the service of the guns, until his ammunition was exhausted. He then manhandled his gun back to the main battery position which had been evacuated, sent his detachment away and sent for a team, which succeeded in withdrawing the gun. During this time he himself kept off the enemy with a machine gun, the Infantry having retired through him to St. Emilie.

30th Divisional Artillery.
148th and 149th Brigades R.F.A.
21st March.

About 11.30 a.m. the enemy had surrounded the three forward guns of C/148th Brigade; these guns continued to fire until captured by the enemy. The teams of the forward guns of D/148th Brigade arrived through a very heavy barrage and limbered up. One howitzer was destroyed by shell fire after it had been limbered up but the other two got away under heavy rifle fire from the enemy who at the time were only 150 yards away.

C/149th Brigade was lent to the 61st Division. Owing to all the orderlies sent to it being killed or wounded on the way, the Battery Commander, a Subaltern, received no orders to retire on the 21st and remained in action at his original position with his guns pulled forward from his gun-pits, firing at practically point blank range till the morning of the 22nd, when he successfully withdrew all his guns under heavy rifle and machine gun fire which caused many casualties during the withdrawal.

A/149th Brigade when it could no longer fire from its pits pulled its guns out to the front and remained in action at point blank range; the enemy being this time right up to the guns. The Battery Commander then withdrew his detachments, carrying their breech blocks, covered by the few rifles at his disposal. This Battery lost 5 guns.

At Eshery—Hallon the Battery Commander of B/149th Brigade rallied some Infantry who were retiring, and with them formed a firing line on a small crest in front of the guns. He then remained in action until both his flanks were completely turned.

On two occasions between the 25th March and 2nd April, the Brigade did not withdraw till the Infantry had passed behind the guns.

This Brigade completely stopped a heavy enemy attack without the Infantry having to fire a shot in front of Merville.

39th Divisional Artillery.
185th and 186th Brigades R.F.A.
March 22nd.

D/171th Brigade withdrew to Tincourt from which positions it was able to do very heavy execution at short range amongst the

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enemy advancing over the Marquaix Ridge, with observed fire.

The 186th Brigade R.F.A. with gun limbers close at hand remained in action until the enemy were within 300 yards and then withdrew successfully.

March 24th.

The line held by the 21st Division on our left was further West, and as the attack North of the Somme on the front of this Division developed, unparalleled opportunities were offered to our Field Artillery. Battery Commanders were not slow to take advantage of this situation. Attacking Infantry and enemy transport moving West along all the roads within range North of the Somme were engaged continually with observed fire.

A detached section of A/186th Brigade did particularly good work over open sights from positions facing North on the ridge N.E. of Hesbecourt, changing position constantly and by making use of their mobility avoided any concentrated hostile shelling.

All day great execution was done by each of the Brigades against the enemy advancing North of the Somme, by means of enfilade fire across the River. On an average as many as 3000 rounds—the majority of this was observed fire—was expended per battery during the day.

March 28th.

O.C. 186th Brigade R.F.A. received a report from the G.O.C., 181th Infantry Brigade to the effect that his line was completely broken, that the enemy held Marcelcave and that a fresh line was being made in rear of that village. At the same time the O.C. 185th Brigade R.F.A. reported that a large number of Infantry were straggling back through his batteries, which however, still remained in action in the same positions from which they were able to inflict considerable casualties on the enemy with observed fire.

The G.O.C. 61st Division has since drawn attention to the excellent work performed by A/186th Brigade on the 28th March.

April 4th.

A heavy hostile attack in massed formation South of Bois des Tailloux was engaged with observed fire by C/186th Brigade and other batteries and was brought to a complete standstill.

Nevertheless, the enemy who was attacking in great strength on the whole front, continued to get men forward in considerable numbers and succeeded in pushing the 14th Division back to the Sunken Road in P. 19, in which most of our F.O.O's. had established their O.P's.

The batteries, however, remained where they were. One forward section of C/174th Brigade in the road at P. 20. a. was finally reached by the enemy but our line was never far behind that point and these two guns were recovered by Major —— during the night.

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The following report from the Heavy Artillery F.O.O. is an instance of the work that was done by our batteries:—

"Two hostile attacks developed about 4 p.m. and 4.45 p.m. The advancing enemy was so heavily punished by fire from our Field Artillery that they lost direction, finally broke up and retired on both occasions in great disorder."

This officer added that he thought the enemy was unlikely to press his attacks further in this quarter as he had been so very heavily punished by our Artillery fire, and his surmise proved to be correct.

During the day most batteries fired 500 rounds per gun observed fire into enemy formations, in addition to concentrations and barrages ordered by higher authority before visibilty admitted of observed fire.

20th Divisional Artillery.

The two Brigades of the 20th Divisional Artillery went into action on the night of March 21st, the 91st Brigade, R.F.A. with 36th Division , and the 92nd Brigade R.F.A. with the 30th Division.

During the whole retirement both these Brigades constantly remained in action engaging the enemy for some time after all our Infantry had passed them.

On one occasion, near Savis, B/92nd Battery, under these conditions, were able to engage at short range and completely destroy an enemy battery coming into action, the Battery Commander observing from a tree in the Battery position.

On 24th March, at Beines, the 91st Brigade R.F.A. were in action covering the Infantry who were retiring from the direction of Villeselve. About 5 p.m. the situation became critical as the Infantry had retired through the Brigade, and the Division on the right had practically ceased to exist, the remnants retiring past the right rear of the Brigade. On the left rear of the Brigade the Germans were pushing on through a big gap in our lines from a northerly direction, with every possibility of cutting off the Brigade. As far as was known, a few cavalry were the only troops opposing this thrust from the North to the immediate left rear of the Brigade. As the Brigade were consequently isolated holding the apex of the battle area at this point, orders were given for two batteries to retire, one at a time, west of Guiscard to cover the next crest in rear where a French Division were digging in. When those batteries had taken up their positions, a third Battery was retired. The remaining battery (C/91) was ordered to hold on till dark. For two hours, this battery engaged the enemy, until all the ammunition was exhausted, one section barraging Villeselve, one section engaging German troops trying to debouch from woods on the right rear, and the third section engaging the enemy in the direction of Le Plessis. A magnificent example of "all round defence", and a cool bit of work by all ranks. By the time the battery retired, Berlancourt was in German hands, and the battery rejoined the Brigade by passing through Buchoire at dusk just before the Germans occupied the village. The Brigade remained in action 500 yards West of Guiscard until *after* the Germans had captured Guiscard.

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These are merely isolated examples of everyday occurrences.

On 25th March, the 20th Division was holding the line of the Quiquerry Canal. Shortly before 11 a.m. it became apparent that the enemy were working round on each flank of the 20th Division. It was thought advisable to withdraw the 232nd Army Brigade from positions East of Billancourt. Orders were accordingly sent to this effect. About 2 hours after, our guns were still heard to be firing from Billancourt. A Staff Officer was sent to investigate and found that A/232 Battery, who had been ordered to cover the retirement of the remainder of the Brigade, were still engaging the enemy at close range over the open sights. A direct order had to be given to the subaltern in charge to withdraw his guns, which was obeyed with reluctance. At this time the enemy were well round both flanks and the guns were firing from the British front line.

On the night of the 25/26th the French took over from the 20th Division, and the Artillery under the command of the C.R.A. 20th Division was left behind to cover the French. During the night, the 20th Division withdrew in a North-Westerly direction to rejoin XVIII Corps. This left a considerable gap between the French and the British at Roye and to the North of it. This gap was filled by two Brigades of Artillery (306th and 307th of 61st D.A.), with few, if any, troops in front of them. They narrowly escaped capture when retiring across the Avre, their extrication only being due to the greatest skill and coolness of all ranks.

On March 28th, a section of C/315 Battery showed the greatest courage in successfully covering the retirement of the 282nd Army Brigade, across the River Avre at Castel, only withdrawing when several men had become casualties from machine gun fire and then getting their guns away in safety.

On April 4th, the 307th Brigade R.F.A. were in action in the vicinity of Ferme D'Anchin. The enemy, using the Bridgehead at Moreuil, attacked in great strength in the early morning from a South-Easterly direction, endeavouring to capture the heights of Rouvrel, and to turn the whole line of the Avre. The 307th Brigade put down a most effective barrage over the heads of the retiring Infantry, and, when the Infantry had all passed them, remained in action firing over the open sights and inflicting extremely heavy loss on the advancing waves of Germans. The Brigade eventually retired when the enemy were right upon them, and every gun was safely withdrawn. The delay caused to the enemy by the fire of this Brigade undoubtedly saved the situation, giving time for the arrival of the French reserves who counter-attacked from the direction of Rouvrel. A number of French officers testified to the heroic resistance offered by this Brigade, and the French Divisional Commander specially commended the skilful and gallant manner in which the guns were handled.

24th Divisional Artillery.

March 21st.

B/107 and C/107 in action in the Western outskirts of Maissemy were involved in very heavy shelling of all natures including gas,

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during the preliminary bombardment, 4 guns being knocked out by direct hits. The detachments manned their guns throughout the whole bombardment and only withdrew when our Infantry evacuated the village when they assisted the Infantry in manning the trenches.

March 23rd.

A/107 remained East of the Somme Canal covering the retirement of our Infantry until the last possible moment. The last section was only withdrawn with great difficulty under intense machine gun and rifle fire after the Infantry had retired behind it.

March 25th.

A/106, on retiring from the line of the Somme Canal, left a section in action about Misery, this section remained in action covering the Infantry on its immediate front with whom the section commander was still in telephonic communication, when enemy Infantry suddenly appeared on either flank within 150 yards. The detachments managed to remove breech blocks and withdraw.

April 4th.

B/107 and C/107 being in action alongside one another, were involved in the very heavy preliminary bombardment which caused considerable casualties to personnel and material. The Battery Commander of C/107 being killed, Temp. Capt. —— (commanding B/107) took charge of the combined batteries and when retirement became necessary, he fought the last gun himself till the enemy were close up to him when he withdrew the gun successfully.

"D" Battery, 150th Brigade R.F.A.

At Heudicourt on the 21st March, 1918, the enemy shelled the gun position of D/150 Battery, which was in a valley, with gas shell until it was impossible to go on firing. The guns were then moved one by one to the crest by No. ——, Driver —— of D/150th Battery R.F.A., with a limber and a pair of horses. Throughout the operation the enemy shelled the position with high explosive, and the route was a track through shell holes.

All the guns were got into position within an hour quite safely, the Battery continuing to fire throughout.

If the driver had not shown great fortitude, the operation could not have been carried out.

Anti-Tank Guns.

There were two Anti-Tank guns on the front of the 30th Division. One fired all its rounds (100 H.E. and 50 Shrapnel). The N.C.O. in charge then destroyed his gun and successfully withdrew his detachment. No news has been received of the other.

The 18th Corps report states: "Of what befell the Anti-Tank Guns in the forward zone, but little is known. There is a report of one

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anti-tank gun whose first target was hostile Infantry at 50 yards. 50 rounds were fired and then the gun was successfully destroyed. In another case our Infantry report that an officer with an Anti-Tank gun, the sole survivor, was last seen surrounded by the enemy with his back against the gun defending it with a revolver. In a third case, all rounds were fired (450) and the gun then destroyed".

From the report of the 16th Divisional Artillery:

"There were four anti-tank guns on the front. There is no news as to what happened to three of the guns because all the officers and men manning them are missing. It is known that they were still firing after the enemy's Infantry had swept over them, so there is every reason to suppose that these resolute men sold their lives dearly. Of the fourth anti-tank gun there is a record from an eye-witness. The Germans were not seen, owing to the fog, until 200 yards off. The gun fired off all its ammunition except 25 rounds (175), and then only stopped because the enemy absolutely mown down by this fire at close range, abandoned the attempt to advance up that particular valley. The detachment then stood by waiting for an opportunity to discharge their last 25 rounds before withdrawing. No more has been heard of them.

HEAVY AND SIEGE ARTILLERY.

The following table is given shewing data about Equipments and Ammunition in order that the enormous amount of physical toil which constant firing and change of position of Heavy guns and Howitzers involves, may be realised.

Nature of Equipment.	Total weight behind team or tractor.	Rate of travel on road.	Weight of Shell.	Number of complete rounds to a ton.
60-pdr.	5½ tons.	3 m.p.h.	60 lbs.	25
6″ How.	4¼ ,,	4 ,,	100 ,,	20
6″ Gun	7½ ,,	2 ,,	100 ,,	15
8″ How.	13¾ ,,	2 ,,	200 ,,	10
9·2″ How.	13 ,,	2 ,,	290 ,,	7

In addition, it should be remembered that batteries worked short handed during this period. Casualties could not be replaced immediately, and men who, for various reasons, were sent away from Battery positions, often failed to find their Battery again owing to the frequent changes of location.

The narratives of 138th Heavy Battery, R.G.A. (6 60-pdr. Guns) and 220th, Siege Battery, R.G.A. (4-6″ 26 cwt. Howitzers) are representative of the experiences of all Heavy and Siege Batteries on the front of the Fifth Army during the last ten days of March, 1918.

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138th Heavy Bty., R.G.A. III Corps Heavy Artillery. March 21st —April 3rd, 1918.

March 21st.

The battery was in position as follows:—

Forward Section—2 guns at the cross roads South of Remigny, remainder of battery in reserve position in Bois Hallot east of Failloue1. Both sections commenced firing about 5 a.m. on S.O.S. lines. The fog was so thick that laying was difficult even with the parallelscopes close up to the guns.

Taking the forward section first. These guns were in action pretty well continuously all day till 5 p.m. From 5 a.m. to 9 a.m. shells were continually dropping all round the guns, but were apparently intended for the cross roads. About 9 a.m. the section was effectively neutralised for nearly 1 hour with a rapid burst of 4·2 Howitzers. Direct hits were obtained on entrance to B.C. post and round both gun pits, but no damage was done and only one casualty was caused—all telephone lines however were cut. No definite news could be obtained of the situation and though touch was kept up with the O.P. till nearly 9 a.m., the fog was too thick for the F.O.O. to actually see anything and could merely report information gleaned from wounded, etc. About 10.30 a.m. Sergt. ——, who had been one of the F.O.O's. party, came into the battery and reported having left the O.P. Fort Vendeuil about an hour previously and having come through a fairly heavy barrage on the road down. He brought a note from Lieut —— the F.O.O. asking for more wire to renew communication with. This was the very last heard of the F.O.O's. party till 3 p.m., when 2nd Lieut. —— arrived at the position in a somewhat dishevelled condition and without any equipment or even puttees. He reported as follows:— "About 10 a.m. finding all communications had gone beyond hope of repair and that the enemy were reported to be in the village of Vendeuil, he determined to get out of the fort and find out what he could and rejoin his battery. No sooner had he got outside the fort with the two telephonists than he found a party of 200 to 300 Germans all round him and was forced to be taken prisoner. His captors appeared to belong to a Brandenburg Regiment. They at once removed all his equipment and took him along with them as they advanced towards Fort Liez. They were eventually held up by Machine Gun fire and a firing line was formed for attack. The prisoners, about 16 in number, were left behind a dug-out of a captured battery position with a guard of a sergeant and two men. The sergeant was eventually shot and after two other Germans had joined the guard the whole party started moving to the rear, by means of one of our communication trenches. Three Germans and 12 prisoners were hit by rifle fire leaving one Hun and four prisoners. What was the exact fate of the one Hun is not known, but the four prisoners, it is believed, all got back to our lines. 2nd Lieut. —— who was one of the four had a particularly unpleasant time running back towards our lines, being sniped at by both sides, however, by crawling along trenches and making dashes from point to point he

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managed to get back to a field battery and from there back to his own battery. The two telephonists, Gunner —— and Gunner —— were both wounded and unable to escape, but Lieut —— speaks highly of the way they were treated by the German N.C.O's. and men."

About mid-day the fog had lifted sufficiently for the ridge of Fort Vendeuil to be seen and the Battery Commander went to a temporary O.P. in the ruins of Remigny village and was able to turn the guns on to bodies of the enemy as they came over the ridge. The O.P. was eventually destroyed by a burst of 4·2 fire, and one of the telephonists severely wounded. Communication was kept up however by runners, and the telephone line was got through again, but about the same time orders were received for the two guns to pull out and retire to join the remainder of the battery at Bois Hallot. The section eventually moved off at 6.30 p.m. Considering that the detachments had been firing almost continually from 5 a.m. and that many of the switches were over 80 degrees, the way in which the guns were pulled out and ammunition loaded up was exceedingly creditable. While moving out hostile aeroplanes frequently fired bursts of machine gun fire round the position.

The remainder of battery had been active all day but had not had much retaliation. The two guns from Remigny reached there about 10 p.m. and pulled into position. They had no sooner got the trails down than orders were received to move this section off to a position to be reconnoitred at once, near Villequier Aumont. The reconnaissance was difficult owing to a fog and a pitch dark night and the fact that everybody else was trying to occupy all the side roads. By 6 a.m. on the 22nd inst., the two guns were in position and ready to fire, and the gunners were able to get something to eat and a few hours sleep after a very strenuous 24 hours.

March 22nd.

The 3 guns in Bois Hallot were in action all the morning and the enemy soon began to drop shell all round the wood. About 2 p.m. orders were given for these three guns to draw out owing to the progress of the enemy. The gun teams and wagons were assembled at Frieres Faillouel near Brigade Headquarters, and the teams were sent up as required, the guns being pulled out as far as possible by hand to save the horses being exposed to fire longer than necessary. The pulling out of the guns was done under the supervision of Lieut. —— who has since been awarded the M.C., and the senior No. 1 Sergt. —— has been awarded the M.M. The first gun was got away successfully, but by the time the second gun was being pulled out the situation had been spotted by the Hun aeroplanes who continued to circle over at a low height and fire heavily with their machine guns. The shelling was also heavy at times, but the men were extremely lucky and kept free of casualties. The second gun was got away from the actual position with some difficulty, the horses being frightened and refusing to work and horses from wagon teams having to be used to assist. This gun got about 200 yards from the position and then stuck in a shell hole effectually blocking the way for the

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third gun. A fresh team was sent up to try and move it. Meanwhile all the wagons had come up and loaded up with as much ammunition and stores as possible—these wagons being able to get away by a track unfit for the guns. The fresh team were unable to move the gun and a heavy burst of shrapnel was put over, wounding one of the drivers and horses and forcing the remainder to take cover. This happened every time an attempt was made to move the gun, the enemy being able by this time to see direct on to the position. Under orders of the Battery Commander all the remaining personnel were withdrawn from the position with as much kit as they could carry. A heavy burst of H.E. was put right into the position and the last wagon was upset, the drivers and horses wounded and wagon broken. By this time the actual situation as regards the position of the enemy was obscure and the Battery Commander thought it advisable to disable the guns in case they could not be got away by night. Having sent the remainder of the battery back to Villequier Aumont he, himself, went back to the position with Sergt —— during a lull in the firing and removed the mechanism from both guns and hid them by throwing them into a deep muddy pool in a stream close by, each mechanism having a cord attached to it which was buried in the bank of the stream so that they could be pulled out again if possible. All dial sights, etc., were removed before by the limber gunners. About midnight Sergt. —— with a fresh team of horses went back to try and draw the two guns out. He was successful in removing the one that was stuck in the roadway and brought it back, but he was unable to approach the gun in position owing to heavy fire. He showed considerable pluck and resource in the whole of his work, and the drivers with him are deserving of all credit for work done under difficult and anxious conditions. At 2 p.m. on the 22nd the section that had withdrawn the night before were firing again.

March 23rd.

By the early morning 23rd the four guns remaining with the battery (one was out of action at the wagon lines for repairs before the 21st) were all in action near Villequier Aumont. Two ammunition wagons bringing up ammunition were shelled in the village, and casualties caused to drivers and horses. At midday orders were received for the whole battery (complete with wagon lines) to withdraw to take up a position near Guivry. By 5 p.m. the whole battery had passed clear of Guivry village, the guns came into action in a position just behind the village and the wagon lines bivouacked about 1 mile further on. Moving warfare conditions now started, the guns coming into action with ammunition wagons alongside them. The guns were firing all night.

March 24th.

At 10.30 a.m. an urgent message was received from 51 Brigade for battery to clear out as the Hun cavalry was reported in Commechon. The battery marched Beaugies and Maucourt to Grandru,

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the horses having a very steep and heavy pull up through the Bois de la Cave. Six wagons had been sent off early in the morning to try and obtain some ammunition from Guiscard and consequently there were extra heavy loads for the remaining wagons, the weather had also turned much warmer and the horses began to feel the heat considerably.

At 2 p.m. the guns came into action just off the road between Grandru and Baboeuf. Ammunition was dumped beside the guns and only gun teams were left behind—the rest of the battery moving on to find lines further back. The guns were quickly registered by means of air bursts over Bois de Caumont which was visible from the battery position. The O.P. was established about 400 yards in front of the guns and a telephone laid and communication established with the Brigade. Harrassing fire was directed on the villages of Bethancourt and Neuflieux. A 60-pdr. Gun was found in a workshop at Baboeuf ready for firing except for a sight, and the I.O.M. was only too pleased to find somebody with a team to take it off his hands. A sight was taken off one of the other guns which had gone out of action through a cracked saddle.

The remainder of the battery had meanwhile moved first to near Sallency and then had moved on again to pass through Noyon. This order was again cancelled about 9 p.m. and a D.R. sent to bring them back to Sallency where they arrived about 11 p.m. Meanwhile at 6 p.m. the guns had been withdrawn from this position and with much difficulty owing to the congestion of traffic on the roads, had succeeded in getting back to Sallency and took up a position on the east side of the village at 10.30 p.m.

March 25th.

At 1 a.m. the battery was ordered to move back through Noyon to Suzoy and reached there at 6 a.m. Horses and men were showing considerable signs of fatigue. The distances had not been very great but the horses had been on the road, except for two short halts of an hour, since 10 a.m. the previous morning and the latter part of the march had been in congested traffic with the frequent sudden halts and starts which are so trying with heavy loads. The men were getting footsore. Here, however, we were all able to get a good wash and a few hours sleep, and what was more a good meal. At 2 p.m. the guns were ordered to take up a position West of Suzoy and by 5 p.m. the guns were ready to open fire.

At 7 a.m. an urgent order to move was sent to the battery and the guns were pulled out again and an exceedingly trying and unpleasant march ensued. The roads were blocked, and a general atmosphere of anxiety as to the close proximity of the Huns seemed to be prevalent, the column got split up and mixed with Siege batteries and it was not until 2 a.m. that the last of the battery had passed through Thiescourt towards Mareuil.

March 26th.

At 6 a.m. the column moved off on the road to Margny and halted on the side of the road. The battery commanders were

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summoned to receive orders from the G.O.C., R.A., 3rd Corps near Elincourt. At noon the battery had reached Marqueglise and wagon lines were formed there. The gun teams and wagons were however not yet to have any rest. At 4 p.m. they pulled the guns to Vandelicourt and no sooner had they got into position, than fresh orders were received to move at once to a fresh position at the top of the hill at L'Ecouvillon. At 1 a.m. after a very hard struggle up the steepest of hills on which two teams and all the men had to get on to each gun in turn to get it up the hill; the three guns and wagons only arrived to be met by orders to return again to Vandelicourt. Vandelicourt was reached again at 5.30 a.m., and men and horses fell asleep from sheer exhaustion practically where they halted.

Since they had left Suzoy where they had had at the most 5 hours sleep or rest, the men and horses of these 3 guns and wagons had been on the go (except for two hours at Marqueglise) for nearly 30 hours—during which time they had pulled into three different positions and out again and marched some 24 miles. Meals had necessarily been very scratch affairs and the horses had had to go with short water ration.

I attach a table showing approximate times in action and on the march from March 21st to March 27th, and distances covered along the road.

(Sd. ——, Major.
138th Heavy Battery, R.G.A.

TIME AND MARCH TABLE.

				Miles.
March 21st	5 a.m.	— 5 p.m.	Forward section in action, firing.	
	6 p.m.	— 9 p.m.	Pulled out—forward section ... ...)	
			Forward section on the march ...	3
			Forward section pulled in Bois Hallot	
			Forward section pulled out Bois Hallot)	
	10 p.m.	— 4 a.m.	Forward section marched to Villequier	4½
March 22nd	9 a.m.	— 3 p.m.	Remainder section firing at Bois Hallot	
	7 a.m.	—12 noon	Pulling out Bois Hallot.	
	12 mn.	— 3 a.m.	Pulling in Bois Hallot.	
			March to Villequier Aumont	4½
	2 p m.	—10 p.m.	Section at Villequier Aumont, firing.	
March 23rd	7 a.m.	—12 noon	In action, Villequier.	
	1 p.m.	— 5 p.m.	March to Guivry	5
March 24th	12 mn.	—10 a.m.	In action, Guivry.	
	10.30 a.m.	— 2 p.m.	March to Baboeuf...	5½
	2 p.m.	— 6 p.m.	In action near Baboeuf.	
	2 p.m.	— 4 p.m.	Wagon lines march to Salenoy ...	3
	5 p.m.	—11 p.m.	Wagon lines march to Noyon, and return—Salenoy	7
March 25th	10.30 a.m.	—12.30	In position, Salenoy.	
	1 a.m.	— 6 a.m.	March, Salenoy to Suzoy	7
	2 p.m.	— 7 p.m.	In position W. of Suzoy.	
	6 p.m.	—)	March, Suzoy to Mareuil via Dives ...	12
March 26th		4 a.m.)	On the march and halted on the road	
	5 a.m.	—noon	to Marqueglise	3
	4 p.m.	— 6 p.m.	March to Vandelicourt and pulled into position	1½
	6 p.m.	—)	Pull out Vandelicourt and march to	
March 27th		5 a.m.)	Ecouvillon and back	9
			Miles	65

9 positions in action in 7 days.

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On the morning of March 21st, 220 Siege Battery R.G.A. was in position near Clastres (G.28.c.66CNW). At 4.40 a.m. we were roused by heavy enemy barrage and hostile shelling of Clastres and vicinity with 150 mm. Gun. 10 rounds fell in the Battery. The order was given for the battery to stand by, and Lewis Gunners took post. All telephone communications remained intact but no news could be gained. An officer was sent to 14th D.A. Headquarters in order to gain information as soon as news came through. He reported at 12.10 p.m. that enemy had broken through and was advancing on Essigny. This was reported to 66th Brigade H.A. At 12.45 p.m. an order was received from Brigade to "defend left Corps". All four guns opened fire four minutes later on B.26.a.00.70.

During the course of the day two subaltern officers and 14 men of 325 Siege Battery reported to this battery for temporary duty on the instructions of 66th Brigade. These officers and men remained with the battery until about the 29th March, and though they had a very trying experience on the morning of the 21st March, did very good work and their assistance was of great value to this battery During the afternoon also one or two stragglers from other batteries both field and siege whose guns had been lost were collected and kept with the battery until at different times orders were obtained as to where they were to report.

At 5.10 p.m. orders were received by D.R. from 111 Corps H.A. and 56th Brigade to pull out one section at a time and proceed via St. Simon to Flavy-le-Martel. At the same time the four battery F.W.D's. and four of the battery lorries arrived at the position to move the battery. On instructions from 66th Brigade a small guard on the ammunition was left at Clastres.

B.C. reported to 111 Corps H.A. for orders, and returning into position in rear of Flavy ammunition dump. Communication was established with 111 Corps H.A. and 56th Brigade H.A. through existing wire at dump. All four guns were reported in action at 10.55 p.m. and Bdr. —— was sent back with a lorry to Clastres to pick up all tubes and fuzes there, and also to bring back the guard, permission having been granted by the 56th Brigade, the proposed movements of the Infantry having by this time come to the B.C's. knowledge. Bdr. —— returned safely with fuzes and tubes but was unable to find the guard.

March 22nd.

Orders to pull back into vicinity of Petit-Detroit from 111 Corps H.A. were received at 8 a.m. Co-ordinates of 66th Brigade were received from Major —— 111 Corps H.A., C.B.S.O. When the battery pulled out, a machine gun barrage was playing on it. Guns and stores were removed safely to a position taken up R.27.a.95 (66D). Stores were unloaded and four F.W.D's. and four lorries returned to Flavy ammunition dump under Bdr. —— with 20 volunteers to obtain ammunition. 600 rounds were obtained. Capt. —— reported to Col. ——, 66th Brigade and gave him the position of the guns. Col. —— had no targets to give him and the battery stood by for further orders. Communication was established with

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Brigade H.Q. and wth 137 Heavy Battery. At 3 p.m. orders were received from Brigade H.Q. to fire on the railway bridge at Montescourt. 200 rounds were fired up to 8 p.m. when orders were received to fire on the canal bank at M.15.a.16. This fire was continued throughout the night. During the afternoon one lorry proceeded to Faillouel where battery rest billets had been, to collect kit and stores which had previously been abandoned owing to lack of transport. Faillouel was being shelled and the Quartermaster's Stores were demolished whilst the party was there.

March 23rd.

During the early morning of the 23rd many rumours were current of the enemy again advancing. Orders were received from 66th Brigade at 5.10 a.m. to fire all remaining rounds, pull out and proceed to vicinity of Neuville-en-Beine, keeping within range of Jussy. This was done and a position taken up near Vatompre Fm. in X.14.b. (66D). While in this position we met an R.E. officer who had blown up the Motte Dump early in the morning of the 22nd. 66th Brigade had moved and Capt. —— did not know their whereabouts, he managed however, to find a line which gave him communication with 111 Corps H.A. and spoke to Major —— giving position of battery, asking for information and targets. 400 rounds turned up and were unloaded. Col. —— arrived in his car later and gave orders for battery to pull out immediately and to proceed to Guivry. This was done. Capt. —— reported to 66th Brigade at 2.30 p.m. A position was found but Col. —— afterwards decided that it was too far back and the battery moved up to X.19.c.73 (66D). Orders were then received to fire on Flavy-de-Martel. Two guns were laid on ammunition dump previously occupied by us and good results observed. Firing was continued throughout the night at different rates.

March 24th.

Just before 5 a.m. on the 24th written orders were received from 111 Corps H.A. to pull out and retire to Beaugies. The orders said we were now under 56th Brigade for tactical purposes. The battery pulled out and retired as ordered, taking up a position on the Eastern outskirts of Beaugies. The battery was reported in action to 56th Brigade who gave targets and fire was opened. Four lorries containing 6" ammunition were discovered without a destination. This ammunition was taken over by us. At 1 a.m. a French Field Artillery officer reported the advance of enemy cavalry at Commenchon. A sharp look-out was kept in front of the battery and the B.C. observed Hun Cavalry proceeding from Les Hezettes, across the front of the But de Minunes. Orders were received from 56th Brigade to pull out and proceed through Quesmy to Noyon-Guiscard road park and await further instructions. Proceeding through Quesmy the Staff Captain, 111 Corps H.A., met the B.C. and asked him if it were possible to go into action here and how many rounds we had. He was informed it was possible and that there were 150

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rounds in the battery. Major ——, commanding 56th Brigade arrived in his car and gave orders to pull in to the nearest possible spot, fire gun fire on Ugny and report when ammunition was expended. 2 guns were pulled into position, lines laid out and fire opened within 7 minutes of the order being received. The 150 rounds were expended in about three quarters of an hour, each lorry as it was emptied being sent back to Noyon for more ammunition. The Brigade commander of 66th Brigade arrived and ordered us to remain in position until more ammunition arrived. About 7 p.m. no further ammunition having arrived, the Brigade Commander of 56th Brigade ordered the battery to retire in the direction of Crissolles, stating that the Brigade Headquarters were going there. On the road the battery was stopped by a Brigade Commander of 66th Brigade and told to take up a position between Quesmy and the Noyon—Guiscard road. No reasonable position being found in the spot indicated, a request was sent to 66th Brigade at Quesmy for permission to go West of the Noyon road. 66th Brigade after consultation with the French ordered the battery to proceed to Rimbercourt and await instructions. The battery proceeded to Rimbercourt but fire was not opened as darkness had fallen and no information could be obtained as to where the enemy were. About 11 p.m. no orders having been received and some French which were at Rimbercourt having long since retired, it was deceided to retire to Crissolles. This was done; then the place being practically deserted, an officer went to Noyon in the hope of finding Brigade Headquarters or Corps H.A. Headquarters. Noyon being found deserted, save for Artillery and transport retiring westwards, the B.C. decided to retire across the Canal at Noyon. The battery was accordingly fetched from Crissolles and just North of Noyon was met by the Brigade Commander of the 66th Brigade who gave orders to proceed via Noyon, Labroycand Luzoy to Guy. On arrival at Guy the battery was met by 66th Brigade was ordered to park until a position had been selected. While the battery was at Guy the battery light car which had been detailed for duty at Corps H.A., Headquarters prior to the 21st March, returned to the battery. Previous to this, all reconnaissance work had to be done on foot. About midday the battery was ordered by 56th Brigade to select a position in the valley just North of the village. A position was selected, but was not approved by Brigade, as it had been reserved for another battery, and instructions were given to proceed through Langy to Candor, and take up a position which was being vacated by a 9·2″ battery. In passing through Langy the battery was stopped by 56th Brigade who were acting in conjunction with the French and ordered to turn about and retire through Lassigny to a position at Balny Farm. The B.C. leaving the guns at Lassigny proceeded to the spot named and found it impossible to get the guns in there, the whole area being full of French Field Guns. The B.C. went back with the intention of reporting these facts to Brigade H.Q. and found that they had moved. The B.C. walked to Guy where they were supposed to be but could not find them; he however saw the Brigadier General 111 Corps H.A. in his car and asked for instructions. He was instructed

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to stand fast and 56th Brigade were afterwards discovered at Dives with French Division, and the situaton reported to them. Major —— rejoined the battery late this night. At about 5 o'clock in the morning of the 26th March, orders were received to get into action at Lassigny. This was done and fire was opened on targets given by 56th Brigade. About 10 a.m. orders were received to retire to St Claude Farm about 2 kilos from Siescourt, and the battery got into action at the place ordered. Fire was opened on given targets. one gun was taken further forward for a short time in order to fire on Candor. The position at this time was very obscure, the line in front of the battery being held by the French, and the B.C. was instructed by the 56th Brigade to remain at St. Claude Farm as long as he thought it safe to do so and then to retire and take up a position just North of Elincourt and report to Brigade at Ecouvillon. At 10 p.m. the trenches in front of the battery which had been manned during the afternoon by French Infantry, were found to be empty and much French transport was seen retiring; the Battery Commander after trying unsuccessfully to obtain any definite information from the French, retired with the battery to just South of Elincourt, being unable to take up a position North of it. This fact was reported to 56th Brigade who ordered the battery to remain at Elincourt for the night and proceed along the Senlis road to Gournay or thereabouts in the morning. The battery accordingly left Elincourt at 8 a.m. on the 27th and parked on the Senlis road about a kilo South of Gournay. During the afternoon orders were received to proceed at 8 a.m. to Bourmont. This was done and the battery was in action at Bourmont by dawn on the 28th. The Battery remained in this position until 5.30 p.m. on the 30th March, firing more or less continuously on targets allotted by Brigade. During this period the situation was, so far as the battery was concerned, one of normal trench warfare, save that difficulty was experienced in obtaining rations and ammunition. On one occasion, one of the Column sergeants who had been sent back with three lorries to fetch ammunition, was forbidden to proceed beyond Gournay owing to the alleged pressure of the enemy in that village. The sergeant in question knowing where his battery was, and knowing it was urgently in need of ammunition disobeyed the order and brought the ammunition safely to his battery. It might perhaps be mentioned that on the 28th March at the request of the French, 18 rounds were fired on cross-roads in Lassigny and the French Infantry sent to Brigade a message complimenting the battery on the shoot, and stating that large bodies of the enemy were seen to run from the road in all directions. At 6 p.m. on the 30th March, orders were received from the Brigade to expend all the ammunition in the battery upon the target then being fired upon, and thereafter to pull out. This was done, but at 6.30 p.m. the order to move was cancelled and the guns were got back into action. More ammunition was sent for and firing was continued throughout the 31st March. By 9.30 p.m. on this day all ammunition had again been expended except half the echelon, and on instructions from Brigade the guns were pulled out at midnight and the battery left Bourmont and proceeded by stages to the collecting and re-fitting area.

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From dawn on the 21st March to dawn on the 28th March, the strain on the whole personnel of the battery and the battery column was very great. The battery was either continually actually firing or on the move and very little sleep was obtained. Owing to an abandoned ration dump being discovered there was no actual shortage of food, but meals were few and at irregular intervals owing to the fact that the battery was very rarely stationary for a sufficient time to prepare a proper meal. Attention is, however, especially drawn to the Nos. 1 of the two guns that were got into action at Quesmy viz :—Sergt. —— and Bdr. ——. The whole of the battery assisted in manning those two guns, but these two N.C.O's. worked with remarkable speed and endurance, and indeed worked themselves to a standstill.

This battery came under me personally on the night of the 25th and fired from 3 positions on the 26th, from 6 a.m. till 10 p.m. and remained under me till the 31st. The morale of the battery was wonderful and they did very fine work.

(Sd.) ——, Lt.-Col., R.G.A.
Commanding 56th Brigade, R.G.A.

25th Heavy Battery. (Six 60-pdr. guns.)

This battery when in position at Curlu was ordered to expend all ammunition before withdrawing. To comply with this order the battery remained in action until all Artillery units had left the vicinity, and Infantry were passing through the position. As the battery retired down the hill, the enemy Infantry were observed advancing up the reverse slope.

This battery occupied thirteen positions between March 21st and March 28th, and fired approximately 300 tons of ammunition.

128th Heavy Battery. (Six 60-pdr. guns.)

After one gun had been temporarily left in position when a new position was being taken up by the remainder of the battery. Sergt. ——, the No. 1 of this gun, took his team back and withdrew the gun after the Infantry had passed through the position.

130th Heavy Battery. (Six 60-pdr. guns.)

This battery remained in action at Hinacourt all the morning of 21st March under very heavy Artillery fire which caused many casualties—one gun lost, 9 men killed and severely wounded out of its detachment of 10. During the afternoon, when ordered to retire, the guns were pulled out under rifle fire from the wood 200 yards in front, and the retirement was carried out under cover of one gun left in position for this purpose.

This gun had eventually to be abandoned after being made unserviceable, and loaded in a manner calculated to cause casualties

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amongst the enemy, should they attempt either to fire or unload the gun.

144th Heavy Battery. (Six 60-pdr. guns.)

After firing all the night of the 27/28th March it was found at dawn that the Infantry had retired behind the battery and was thus left in front of the front line. The gun and first line wagon teams were sent for and the position defended by the personnel of the battery armed with rifles and the battery Lewis Guns, until the teams arrived. All the guns and wagons were safely withdrawn under heavy machine gun fire.

33rd Siege Battery. (Six 8" Howitzers).

On 21st March the forward section of the 33rd Siege Battery continued to fire until 75% of the gun detachments had been casualtied. The remaining men then manned one gun under the section officer who also acted as No. 1 and gun layer, and continued to fire till 10p.m., when orders were received to retire. One gun was safely withdrawn, but the other had to be rendered useless and abandoned as the road was destroyed. The rear section of this battery fired 3000 rounds by 5 p.m. 22nd—a weight of 300 tons of ammunition from 2 Howitzers in two days. By this time the enemy was only 500 yards from the guns which were in front of our Infantry. All guns were, however, safely withdrawn by three caterpillars under heavy M.G. fire and came into action again the same night.

110th Siege Battery. (6" Howitzers).

This battery had two guns knocked out at 7 a.m. 21st March. The remaining guns in close liaison with the South African Infantry Brigade fired 1536 rounds on various targets. At 8.30 p.m. the battery was ordered to retire. The only available transport was 3 F.W.D's., but all guns, personnel, essential stores and 400 rounds of ammunition were safely withdrawn. The guns were manhauled about 2 miles owing to the lack of transport.

144th Siege Battery. Four (6" Howitzers).

On March 23rd the Right section of this battery at M.35.d. (Sheet 66c S.W.) fired on several Infantry targets, O.K's. being reported on large bodies of troops near Fort Liez causing their dispersal. The nearest target was 1300 yards away. The gunners behaved admirably under trying circumstances, exposed as they were to indirect fire from machine guns, and sniping from low flying 'planes.

Observation from this position was carried out by 2nd Lieut. —— at M.36.a.7.4. (Sheet 66c S.W.) who had the battery Lewis

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Gun with him; this Lewis Gun was used with great effect and inflicted many casualties in parties of Infantry advancing towards the St Quentin Canal.

The loss of the guns of this battery and of 106th Siege Battery is worthy of mention. A block on the road near Bethancourt was caused by a direct hit of a 4·2″ How. shell on a French vehicle and team. A F.W.D. and gun of 106th S.B. were ditched in trying to circumvent this obstacle, and the remainder of 106th S.B. and 144th S.B. were strung out on the road behind. The road was at the time being shelled heavily by 4·2″ Hows., and was under rifle fire from the wood 300 yards on the flank. All guns were made unserviceable by their detachments and the lorries set on fire by means of petrol. During the time that the guns were being put out of action many casualties were suffered and three direct hits were obtained by the enemy on guns and transport on the road.

The personnel of the two batteries were then collected and retired through Bethancourt.

153rd Siege Battery. (Four 6″ Howitzers).

At Amigny Rony during the whole of 21st March remained in action under heavy and continuous fire of both H.E. and Gas shell.

Besides the work of serving the guns, the road leading to the the battery position had constantly to be repaired by the personnel of the battery in respirators, under heavy fire, in order to ensure the ammunition supply.

168th Siege Battery. (Six 6″ Howitzers).

On March 25th this battery remained in action after all batteries near it had been withdrawn. It was still firing when the Infantry were using gun positions as the support line. The battery was then withdrawn successfully, all stores and all remaining ammunition was packed and taken away with the battery.

175th Siege Battery. (Six 9·2″ Howitzers).

Some of the work done by this battery was exceptionally fine. On the 22nd March an average of 300 rounds, representing a weight of over 70 tons of ammunition for one gun alone. Later on the 22nd this battery pulled out of position, the enemy being within 400 yards of the position when the last gun was cleared.

On the 23rd inst., a position was evacuated with all gun stores, including the emptying of earth boxes and removal of fire beams, in just over 1½ hours from the time the order was given.

On the 25th inst., a gun was put into position, including the digging of pits, in two hours.

In normal times a 9·2″ Howitzer battery considers it has done well if it gets into action in 12 hours and out of action in 6 hours.

214th Siege Battery. (Six 8″ Howitzers).

On the 21st March, one section of this battery remained in position until it had fired all its ammunition. The last targets were

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engaged under cover of fire from the battery Lewis Guns. This section was withdrawn when the enemy were within 200 yards of the battery position.

255th Siege Battery. (Six 6" Howitzers).

On March 21st—22nd, this battery took up 4 successive positions and fired 3720 rounds which represents the handling of approximately 200 tons of ammunition in addition to the heavy labour of constantly changing position. On two occasions the guns were pulled out of position and withdrawn under rifle and M.G. fire, covered by the fire of the battery Lewis Gun.

283rd Siege Battery. (Six 6" Howitzers).

One section of this battery near Liez on 21st March, owing to the approaches of the only road leading to their positions being held by the enemy, had to manhandle their howitzers 1200 yards over rough country in the open to the nearest road in rear of the position. This work was done under heavy fire, and the howitzers were successfully withdrawn.

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A SIMPLE APPARATUS FOR INSTRUCTING GUNLAYERS.

By Capt. R. V. Walling, R.G.A. (T.).

THE following is a description of a very simple "gadget" for making the training and instruction of Coast Defence Gunlayers much more interesting and realistic, which I fitted up from some odds and ends of material with the aid of a single intelligent gunner in 1916. My gun was a Q.F. 4·7-in. "B" Mk. IV piece on a Naval "P III" mounting on the end of a pier. The idea could equally well be adapted to any other gun and mounting.

A ·22″ rifle was lashed to the carriage in such a manner that it moved with the gun when the latter was elevated, depressed or trained, and in such a position that, on being fired, the bullet passed through the part cut in the front of the shield for sighting purposes.

A wooden frame was made to fit into two sockets, fixed to the pier (they could equally well be sunk into the ground) at right angles to the line of fire. In this frame, we fixed a large piece of "three-ply" wood to slide to-and-fro in grooves.

On the bottom of the board was pinned a sheet of foolscap paper with a picture target, correctly coloured and drawn to scale for a given range (say 5,000ˣ). The ·22-in. rifle was fixed at such an angle that when the sight was correctly laid on the target, the bullet would pass through a slit cut in the "three-ply" immediately above the target but out of the field of vision of the telescopes.

A piece of paper was pinned over this hole, with a red ink line running across the centre. Each gunlayer was given five rounds, the ·22 rifle being fired by a cord attached to the trigger, with a toggle on the end. While he was firing, the target was drawn from one side of the frame to the other by means of wires and he had to follow it. As he could not see the result of his shooting, this became a real test of personal accuracy.

On conclusion of each gunlayer's series of five rounds, the paper, with the five holes in it, was removed and his name marked on it. Small cardboard gauges were made to measure the distance of each bullet-hole from the centre-line, marked in inches and in degrees and minutes of Tangent Elevation. The M.P.I. and Mean Error for each man was then worked out. The shoots were carried out regularly and the results plotted on a chart which was hung up in the Canteen.

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I found that all the men took a great interest in it and the whole company wanted to qualify as gun-layers after a while! I gave them a graduated series of targets, worked out for varying ranges, starting with a cruiser, then going to T.B.D's at varying speeds and finishing up with merely a periscope, and found that the shooting improved enormously. This was borne out by 1-in. Aiming Rifle and Service Practice.

Further useful purpose was served by this apparatus for night firing. We started by contriving a searchlight out of an electric torch and a cardboard tube, but found this was not much different to daylight practice. A small electric bulb was then fitted at the back of the "three-ply" so that when the current was turned on, three or four specks of light appeared through holes cut in the target. These represented gun-flashes from the hostile craft, and the Gunlayer had to spot them and fire at them as they appeared at irregular intervals.

There does not appear to be any reason why this could not be adapted to a gun fitted with automatic sights. The ordinary autosight test, as laid down in G.A.T. Vol. I, could then be carried out in this manner and a comparison with the results obtained in the ordinary way would be of great interest.

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Contents of R.A. Journal, December, 1918.

The Section Commander. By Major-General H. C. C. Uniacke, C.B., C.M.G. 285

A Note on Ranging with Aeroplane Observation. By Major R. B. Withers, D.S.O., R.G.A. 287

Extracts from Report on Operations. August 21st—September 4th, 1918. Communicated by Major-General H. C. C. Uniacke, C.B., C.M.G. 289

The Official Entry of the Fifth Army Commander into Lille, on 28th October, 1918 292

The Taking of Jerusalem. By A Battery Commander 295

Artillery Training. Communicated. (To be continued). 301

Artillery Graph. By Lieut. H. J. Fisher, Australian Field Artillery 314

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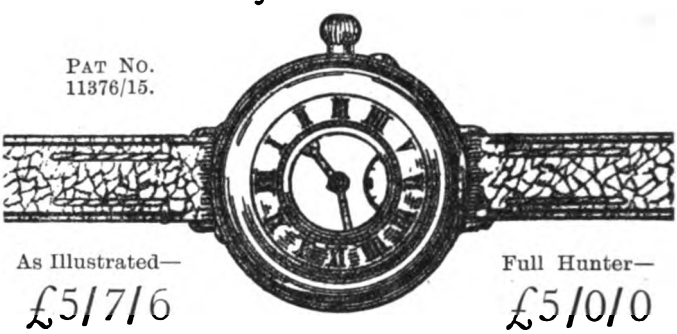

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THE SECTION COMMANDER.

By Major-General H. C. C. Uniacke, C.B., C.M.G.

THE bed-rock of Artillery efficiency is "Section organisation". It is the fact of our having possessed and maintained this organisation that has enabled the Regiment to expand in the manner it has.

A good Battery consists of three well trained Sections and a capable Battery Staff.

The success of the Section is dependent on the Section Commander. Its fortunes lie in his hand. The relation of the Section Commander to his men has no parallel in other spheres in which one man is set in authority over another. He accepts a greater personal responsibility. He is the commander of his men in the fight, their trainer for the fight and the keeper of their welfare at all times. The Section reflects its commander. One Section differs from another chiefly because the capabilities of their respective commanders are unequal. A good Section is a Section well commanded and gallantly led.

Leadership is not born of learning. It depends on simple and straightforward human qualities. A leader, above all, must have the confidence of his men. He will gain their confidence by commanding their respect—respect for the clearness and simplicity of his orders and the firm way in which he insists that they shall be carried out; respect for his sense of justice; for his commonsense; for his keenness, energy and habit of forethought; for his indifference to personal danger and the readiness with which he shares his men's hardships; for his obstinate good humour in face of all difficulties; and for the obvious pride he takes in his command.

The Section Commander who wins his men's confidence has won more than half his aims. He has an instrument to his hand capable of high achievement. The spirit with which he is able to *fire* it will carry it to success through the hardest fighting. Whatever demands he makes on it will be cheerfully and willingly met. Where he goes his men will follow him.

The final test of a Section, a Battery, a Brigade is its fighting spirit.

The battle is only won when the enemy's forces are destroyed, when his troops are killed or captured. The main task of every Battery is to kill the enemy confronting it. This is the simple rule of war. Skill in the performance of this task with the smallest loss

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to ourselves is developed by training. But training is valueless if the fighting spirit—the will to advance at any cost in order to close with the enemy and kill him—be absent.

A boxer content only to "spar" will lose his match and lose it painfully. Troops thrust into battle without the resolve to fight, to win, and to win by fighting will lose and lose with heavy losses.

The fighting spirit of the Section is derived from its commander. In the commander it springs from his own resolute belief in himself, in the supreme necessity for winning the war, and in his country's ability to win it.

Well established principles of fighting and training for Section Commanders are laid down in official manuals. But principles on paper and apart from their application have little value. Their usefulness mainly depends upon the effort of the Section Commander to translate them into the everyday life of his men—and this effort must be made. The virtue most to be cultivated in war is energy. Folded hands and fatalism bring certain failure. To do nothing is to do something definitely wrong. Energy in fighting, energy in training and pride in his work are the Section Commander's sure ingredients of success.

France, 30th October, 1918.

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A NOTE ON RANGING WITH AEROPLANE OBSERVATION.

By Major R. B. Withers, D.S.O., R.G.A.

METHODS of ranging fall into two classes, those in which observations of the fall of shot are purely qualitative, *i.e.*, plus, minus or range; right, left or line; and those in which they are quantitative, *i.e.*, a definite number of yards plus or minus, right or left. To say a round fell plus and right is qualitative, to say it fell 50 yards plus and 10 yards right is quantitative.

In the latter, with which I propose to deal, there is a general notion that the only observations that are serviceable for calculation in a series are those of rounds all fired at the same elevation.

In ranging with aeroplane observation it is rarely possible to get many of these per gun, so most B.C's. range their guns as if the observations were merely qualitative, in other words they practically ignore the observers quantitative observations—so many yards plus or minus, treating them as simply plus or minus as the case may be.

But it is impossible to determine the M.P.I. with any accuracy by this method with only 5 or 6 observed rounds, as so often happens, yet if each observation could be used *Quantitatively*, a very accurate registration could be obtained.

Let us see if this can be done. For convenience and simplicity we will ignore the actual observations, dealing only with observations for range reduced to minutes of elevation. The first round, say, is fired at an elevation of 26° and is observed as falling plus 1°. Now if it were possible to put the clock back and do the whole thing all over again, it is clear that if we fired it at an elevation of 25° we should have hit the target. This ignores the observer's error, which will be discussed later.

* Now let us fire round 2 at 24° 20′ going back our long bracket. This is observed as falling minus 1°. By the same process of reasoning, we see that if it had been fired at 25° 20′ it would have hit the target. We have bracketed our target and already created a presumption that our correct elevation is somewhere about 25°, so let us go straight to this, as the nearer the target, the more accurate

Firing Round 3, at 25° we get an observation of minus 15′ from which we calculate the elevation to hit the target to be 25° 15′.

* This method would appear to be best for finding the M.P.I. and is more orthodox; but in cases where it is desirable to hit target as soon as possible it would be better to use the result of the first round for the elevation of the second round, i.e., fire round 2 at elevation 25° 0′.

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The next two rounds explain themselves.

Tabulating our results, we get:—

Round.	Elevation.	Observation.	Elevation to hit target.
1	26° 0′	plus 1° 0′	25° 0′
2	24° 20′	minus 1° 0′	25° 20′
3	25° 0′	minus 15′	25° 15′
4	25° 10′	plus 10′	25° 0′
5	25° 10′	minus 5′	25° 15′
		Mean	25° 10′

This is of course a very simple example, but the principle is always the same, though I have unfortunately lost all my records of actual shots to illustrate this.

Objections.

While admitting that a gun shoots differently at different elevations, it is contended that the elevations used are on both sides of the mean, so that errors due to this cause tend to cancel one another; and, anyhow, observational errors are sufficiently great to make these negligible.

Regarding observational errors, these are always with us and cannot be avoided. This method enables the B.C. to compile statistics; for the mean error of each gun in every shoot is easily found.

Hence any particularly erratic observer is at once caught out, for all the guns will suddenly develop larger mean errors than usual.

In addition, abnormal rounds and palpable observational mistakes, such as ranging on the wrong target, are at once evident.

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EXTRACTS FROM REPORT ON OPERATIONS.

AUGUST 21st—SEPTEMBER 4th.

1918.

COMMUNICATED BY MAJOR-GENL. H. C. C. UNIACKE, C.B., C.M.G.

5TH DIVISION.

Artillery 21st to 23rd August.

The outstanding feature was the way in which batteries pushed on and took advantage of the tactical situations as they developed. For instance, the 27th Brigade (Major ——) were all in action in the valleys round Logeast Wood by 11 a.m. on the 21st, and the 119th Battery under Major —— (since killed) was able to render material assistance to the 63rd Division (which the Brigade was then covering) by stopping the M.G. fire from Achiet-le-Grand which was holding up the advance.

Liaison with the Infantry was well maintained throughout the operations:—

(1) By keeping the Artillery Group Commander at or near Inf. Brigade H.Q.

(2) By F.O.O's. (*Not* Forward Liaison Officers) who went well forward and were given a free hand to keep in touch with the situation in addition to observing fire. In numberless instances the services of quite junior officers acting on their own initiative were invaluable, indeed one of the most gratifying features of the whole operations has been the way in which young officers of all arms of the service have been prepared to assume responsibility and act on their own.

It was remarkable how the batteries of this Division which had had no experience of open warfare since 1914, adapted themselves to the new conditions.

Signal Communications were maintained by visual in front of batteries, otherwise by telephone. A simple three-letter code for the use of F.O.O's. was found very valuable.

Casualties in the Artillery have been heavy chiefly on the days between attacks. One Battery Commander and his reconnaissance Officer were killed when reconnoitring during an advance.

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Attack of 30th August on Beugny—Ypres Line.

The co-operation between the artillery and the infantry during the operations which have just been described was exceptionally good. In the original barrage, the 27th Brigade R.F.A. (Major ——) had only been able to reach the line of the first objective from the positions they then occupied. During the half hour pause on this objective, batteries limbered up, galloped about 1,000 yards, came into action again and picked up the barrage as it lifted. During the day the 37th Battery (Major ——) rendered particularly valuable assistance to the 1st Battalion, Devonshire Regt. The Battery had attached itself to the battalion and the two Commanding Officers worked together, side by side. Later on D/15 Battery (Captain ——) performed a notable feat, galloping through a heavy barrage and advancing into action in close support of the Infantry into a position not 700 yards from the enemy. The greater part of their advance was carried out in full view of the enemy and under heavy fire. Much of the credit for this advance was due to 2nd Lieut —— who stood for 15 minutes at the most exposed place, a road junction on the crest of a hill, where he directed the passage of the Battery through the barrage. He displayed such skill and presence of mind that every team got through without casualties, though the bombardment continued with unabated force and he himself was in the utmost danger the whole time.

Attack of 2nd/3rd September on Beugny.

An attempt was made to deal with hostile M.G's. by running up 18-pdrs. in close support of the Infantry. One of these forward guns belonging to the 124th Brigade R.F.A. which was handled with extreme gallantry by the Officer in Command, was knocked out almost at once, every man of the detachment being either killed or wounded. Another gun belonging to the 52nd Battery (Major ——) was run up in to a position about 1,000 yards from the enemy, 45 minutes after Zero. 2nd Lieut ——, who was in charge of this gun fired over the open sights on the enemy M.G's. which were holding up the advance, and on reinforcing troops as they came up. He remained in action for 3 hours and got off 70 rounds in all, though he was for the greater part of the time under heavy fire.

During the evening it was decided that the attack was to be resumed next morning. Brig.-Genl. —— plan was to advance up the Chapel Spur from the South with 2 Companies, approximately 120 rifles in all, of the 1st Battn. Bedfordshire Regt., while 2 Companies of the 16th Battalion R. Warwickshire Regt., of about the same strength converged from the N.W. of the village (I.9.c.) Beugny itself was to be kept under very heavy artillery fire, 3 complete Brigades of Artillery being employed for this purpose, while another Brigade of Artillery with 2 Batteries of 6″ Hows. was to fire on Chapel Spur in front of the advancing infantry, batteries stopping fire in turn as the infantry went forward. The fire on Beugny itself

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was to be continued during the advance of the infantry beyond the village. The advance took place and the work of the Artillery was described by the infantry as magnificent, but unfortunately practically all the enemy had gone, and very little opposition was met with.

German Retreat on 3rd September.

The 27th Brigade R.F.A. advanced by bounds of 2 batteries in close support of the infantry with 2 guns pushed well ahead. The whole Brigade was in position in rear of Velu Wood by 2 p.m. and rendered most valuable assistance.

Conclusion.

Scarcely less remarkable was the performance of a Driver in the 119th Battery (Driver—). Just at the moment when ammunition had been urgently demanded by the Battery the wagon lines were heavily shelled. A number of casualties were caused to men and horses, and several teams bolted. Driver — took charge of the situation, rallied all the teams, except two, and set off to the battery positions. In so doing he passed through a heavy barrage but succeeded in delivering all the ammunition. He then went off and spent the whole night in searching for the missing teams and wagons. When he found them he took the place of the lead-driver of one team, who had been wounded, and brought both the wagons up to the battery position and delivered the ammunition. On many occasions too batteries have been commanded by quite junior subaltern officers with remarkable success, in spite of the fact that they were entirely new to open warfare conditions. One of these young officers, Lieut. ——, who was in command of the 120th Battery which had already advanced 5 times in support of the Infantry, was severely wounded whilst the Battery was firing a barrage. He refused to be removed and remained lying behind the guns until the barrage had been completed, encouraging the detachments to continue firing in spite of the heavy shelling. Similar courage was displayed by Lieut. ——, Commanding the 121st Battery, who also when very severely wounded refused to leave his Battery as long as it remained in action.

When it is remembered that the whole of the operations in which the Division were engaged were in the nature of the pursuit of an unbroken enemy fighting carefully staged rearguard actions over ground admirably suited to his temperament and tactics, the fact that the Division was at no time behind the general line of advance, but rather the reverse, can fairly be attributed to the fighting spirit of the Officers and Men on the spot. The instances of this spirit quoted above are a very few selected from existing accounts of the battle. A vast number more passed unnoticed and unrecorded.

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THE OFFICIAL ENTRY OF THE FIFTH ARMY COMMANDER INTO LILLE

ON

28th OCTOBER, 1918.

ON the 17th of October, 1918, Lille, the second largest town of Northern France, was released from the yoke of enemy occupation, that it had borne for four years with such fortitude; four of the longest years within its memory.

On the morning of the 28th of October, Lieut.-General Sir William Birdwood, K.C.B., &c., &c., officially entered the city with his staff, the ceremony constituting one of the historic events in the annals of the town.

A proportion of the Army Staff had moved into Lille some days beforehand, including the Band of the Royal Artillery, Fifth Army. This band the first Allied band to enter the City, on its arrival, commenced giving performances in the town and suburbs, and was everywhere accorded a most enthusiastic welcome, crowds of inhabitants collecting whenever the word went round that "La Musique" was starting.

The setting for such an historic occasion was all that could be desired. A mild day with bright sun, showed streets crowded with inhabitants all making for the routes and places of vantage for seeing the ceremony. Flags, French and British, long treasured and carefully concealed from the enemy, floated from nearly all the windows in the town, a few aeroplanes circled overhead, and in the Grande Place where the Army Commander was to meet the Maire and civil authorities, stands and a dias had been erected, covered with tricolour and bunting.

The chief events in the day's programme included the presentation of the Fifth Army flag to the Maire of Lille followed by the March Past of a Division.

At 10 a.m. the Army Commander and his staff entered the city by the Porte de Canteleu and proceeded by the following route to the Grande Place.

Rue le Gueux.
Rue de Turenne,
Boulevard de Monte Bello,
Rue Leon Gambetta,
Place de la Republique,
Boulevard de la Liberte,
Rue Nationale,
Grande Place.

Here the Army Commander dismounted and was received by the Maire and civil authorities; a speech was read by the Army Commander and the Army Flag was presented to the Maire. The Maire made an answering speech and presented a flag to the Army Com-

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mander; the flag, beautifully embroidered, bore the Arms of the City with the following inscription:—

"Ville de Lille a ses Liberateurs—le 17 Octobre 1918."

The Army Commander and the Civil Authorities then proceeded to the Dais and watched the March Past of the 47th Division.

The Band of the Royal Artillery, Fifth Army was stationed in the Grande Place, played selections pending the arrival of the Procession, and played the Regimental March whilst the 47th Divisional Artillery marched past. The Band of the City Fire Brigade was also stationed in the Grande Place, and took turn about with the R.A. Band in playing selections, finishing with "God Save the King" after the R.A. Band had played the French National Anthem.

Thus under the statue symbolising the City, which stands in the centre of the Grande Place was concluded a ceremony marking a great occasion in the history of Lille, a ceremony symbolical of great promise for the future.

TROOPS WHICH TOOK PART IN THE MARCH THROUGH LILLE.

G.O.C., 47th Division and Detachment of Divisional Staff and Signals.
"A" Infantry Brigade with detachment 1st Line Transport.
"A" Field Company, R.E. and 1st Line Transport of a Section.
"A" Field Ambulance, with ¼ 1st Line Transport.
Divisional Artillery, with a detachment D.A.C.
"B" Infantry Brigade .....
"B" Field Company, R.E. ..... } As for similar Units entitled "A"
"B" Field Ambulance .....
M.G. Battalion with ¼ 1st Line Transport.
"C" Infantry Brigade .....
"C" Field Company, R.E. ... } As for similar Units entitled "A"
"C" Field Ambulance .....
Pioneer Battalion, with 1st Line.
Pioneer Battalion, with ¼ 1st Line Transport.
Detachment of Divisional Train.
Detachment of Mobile Veterinary Section.

Among the officers of the Royal Regiment present at the entry were:—

Lieut.-Genl. Sir A. Holland, K.C.B., M.V.O., D.S.O.
Maj.-Genl. Sir H. S. Jeudwine, K.C.B.
Maj.-Genl. H. C. C. Uniacke, C.B., C.M.G.
Maj.-Genl. H. L. Reed, VC, C.B., C.M.G.
Brig.-Genl. C. M. Ross Johnson, C.B., C.M.G., D.S.O.
Brig.-Genl. A. E. J. Perkins, C.B.
Brig.-Genl. J. F. Laycock, C.M.G., D.S.O.
Brig.-Genl. C. St.M. Ingham, D.S.O.
Lieut.-Col. C. N. F. Broad, D.S.O.
Lieut.-Col. R. S. Ryan, D.S.O.
Major S. A. Boddam-Whetham, D.S.O., M.C.
Major S. D. Douglas Jones, D.S.O., M.C.
Major N. A. L. Day.
Captain B. Honour.

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The following Staff and Unit Commanders of the Fifth Army took part in the March through Lille:—

Maj.-Genl. C. C. Van Straubenzee, C. B., C.M.G. (G.O.C., R.A., Fifth Army).
Brig.-Genl. J. E. S. Brind, C.M.G., D.S.O. (B.G.G.S. XI Corps).
Brig.-Genl. A. F. U. Green, D.S.O. (D.A. & Q.M.G. XI Corps).
Brig.-Genl. S. F. Metcalfe, C.M.G., D.S.O. (G.O.C., R.A., XI Corps).
Lieut.-Col. C. L. C. Hamilton, C.M.G., D.S.O. (A.Q.M.G. Fifth Army).
Lieut.-Col. S. C. Peck, D.S.O. (Actg. G.S.O.I., Fifth Army).

Headquarters, 47th Divisional Artillery.

Brig.-Genl. E. N. Whitley, C.M.G., D.S.O.
Lieut. W. S. D. Marshall, A/Staff Captain.
Lieut. L. Edge, Reconnaissance Officer.
Lieut. H. S. Pound-Corner, Signal Officer.

235th Brigade, R.F.A.

Lieut.-Col. S. W. L. Aschwanden, D.S.O.
Captain P. H. Dodgson, M.C., "A" Battery.
Major S. L. Keymer, "B" Battery.
Major T. H. Flynn, "C" Battery.
Major M. J. K. O'Malley Keyes, "D" Battery.

236th Brigade, R.F.A.

Lt.-Col. The Hon. H. G. O. Bridgman, D.S.O., M.C.
Major W. Cooper, M.C., "A" Battery.
Major N. Christopherson, M.C., "B" Battery.
Major A. F. Yencken, M.C., "C" Battery.
Major S. Taylor, M.C., "D" Battery.

47th Divisional Ammunition Column.

Major H. H. Pollock, M.C., O.C.

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THE TAKING OF JERUSALEM.

BY A BATTERY COMMANDER.

AT 8 o'clock in the morning of the 9th December, 1917, the Mayor of the City and the Chief of Police offered to surrender the City of Jerusalem to three gunner officers. This was accepted.

The M.G.R.A. in Palestine asked me to write an account of what actually happened on the 9th December, on which day Jerusalem fell before the 53rd (Welsh) and the 60th (London) Divisions.

There seems to be some considerable controversy on the part of one or two officers of high rank on the subject as to who first entered Jerusalem.

As regards any individual claiming to be first man in Jerusalem, it is difficult to recognise any particular credit to be attached to this feat. Nor is it of any great interest except possibly to the individual concerned.

The first formed party to enter the town arrived at my urgent request—a mounted party of Gunners, consisting of Colonel Bayley commanding 303rd Brigade, R.F.A., two Artillery Subalterns, and seven armed Artillerymen. Brig.-Genl. Watson commanding the 180th Infantry Brigade, accompanied this party, followed half-hour later by one company of 180th Infantry Brigade, 60th Division, which also I sent for to keep order in the town.

Between the hours of 10.30 a.m. and 11 a.m. the 53rd Division entered the Town from the S.W. along the Bethlehem road past the Jaffa Gate very soon after the arrival of the Infantry company (180th Infantry Brigade).

The surrender of Jerusalem was handed to Colonel Bayley in my presence by the Mayor of Jerusalem at a point about 1¼ miles from the City gates.

Previous to this, Major Beck, 301st Bde. R.F.A. (later killed in the Jordan Valley), and Major Barry, 302nd Bde R.F.A., had wandered up to the outskirts of the town and had seen the Mayor with his white flag of truce.

Here is the little story, such as it is.

The 60th Division had been given the task of capturing the very strong position immediately West of Jerusalem, which included Ain Karim, Deir Desin, and Kulonieh Trench Systems.

This position should have been impregnable. The natural features of this absurdly strong defensive position afforded the enemy every advantage.

303rd Brigade guns were posted in a position under cover of the Kustal Ridge near two trees which marked the sky line immediately South of the Mosque, about 4,000 feet above the sea level.

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The 8th December was spent covering our infantry in their assault on, and fine advance up, the Mountains on the opposite side of the Kulonieh Valley. That night it poured with rain and blew a gale of wind, and when we remembered that two nights ago it had taken us, thanks to the swampy ground and severe climb up to our position, 8 hours, i.e., all through a soaking night, to reach Kustal, it seemed to us as we shivered in the storm, the unbearable last straw that our advance next morning might be hindered and made perhaps impossible by another wet night.

However, at daybreak on the 9th we succeeded in unearthing two guns; two others refused to move; the third Section of my Battery I had kept close to the main Jerusalem Enab Road; and this last one we moved off with down to Kulonieh.

Then on foot with one subaltern and the Group Commander (Colonel Bayley), and Major Price, we faced the zigzag Roman Road which led to Jerusalem, and runs parallel to the Lifta high road, a tremendous pull up for the tired horses.

The Lifta Kulonieh high road was extremely exposed to the North and appeared at that stage of operations out of the question. That was the reason for taking this precipitous track.

Expecting every moment to be met with machine gun fire and shells, we trudged warily up this steep road with the only gun, with its eight thin horses, which had survived the camel-blocked descent from Kustal.

Thus it was that meeting no opposition and seeing none of our infantry, we reached the top and found ourselves not rushed into a bloody fight, but taking a very lovely sunny Sunday morning walk towards the outskirts of Jerusalem.

Presently we saw a crowd of women and children led by an official carrying the white flag of truce. This individual turned out to be the Mayor of Jerusalem with his entourage of Arab Police and laughing girls.

Colonel Bayley was formally handed over the papers which purported to be the entire Surrender of Jerusalem to the British.

Colonel Bayley and the Mayor were at once photographed by an American who also acted as interpreter. The Mayor then pointed out the importance of immediately having the Post Office taken over and all precautions taken of cutting communication with the enemy.

Bayley requested me to do this forthwith.

Leaving the gun and its detachment halted on the road, I took with me an Arab Policeman mounted on a grey pony, and my orderly; no one else being available at that time.

At 8.20 a.m. I started to ride about 1¼ miles into Jerusalem. As I rode through the streets the Policeman shouted wildly that the British were already coming.

People appeared from nowhere, running and shouting and waving their hands of welcome.

I rode towards the Jaffa Gate to the house of Hussein Selim, the Head of Municipality, and demanded the key of the Post Office.

I explained in French to this official that I was the Chief of Police of the British Army now entering the town (a precaution at

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this stage I considered advisable). I required, I said, every Arab policeman available at once; my orders would be implicitly obeyed; if any communication from that time existed with the enemy he knew what punishment to expect; all employées at the Post Office to assemble at that place; the house to be surrounded whilst I searched.

These orders were carefully attended to, and well carried out by the Arab Chief of Police, who had arrived on the scene.

Then I turned up the street through a dense, cheering crowd which had to be forced back by a number of Arab policemen, who had settled all round me like flies from goodness knows where.

I searched the Post Office and placed a policeman over one room in which were cupboards of stamps and official books.

I found all wires cut.

The employées were all herded into one room. Then I came out of the building to find the Plâce in front of the Post Office filled with hundreds of uneasy faces, awaiting the next move.

Here I stood on the door steps for two hours anxiously watching for British troops. The whole Plâce and streets leading thereto were now choked with a sea of faces of every hue, and I appeared to be the centre of interest. Every time I lit a fresh cigarette, or sipped another cup of coffee, the crowd cheered.

I spoke to many officials in French.

A woman of Russian descent ran out from the crowd and wept on my shoulder tears of joy, or possibly sorrow, it was not clear which.

She mumbled out a story of her father being dragged off insufficiently clothed, by Turks, to Jericho, at the same time expressing considerable relief at the sight of a British soldier at last.

Scenes such as this succeeded each other in rapid succession, and "His Excellency", by which I was known, had to deal with variously assorted deputations, and further weeping women. Coffee on silver trays was brought to me at intervals, the period of suspense and anxiety being a long one.

Still no British Army arrived. After the first hour of waiting an Arab gentleman asked me why the British did not arrive as the people were becoming uneasy, and the Turks were still in the town. I told him that in good time they would be here, and said that even now the British guns were just up the road.

An hour and a half went by, still no sign of British troops.

The Musselmans were showing signs of unrest. Why did the British not come? Could I possibly send and ask for a display of troops of some sort? They could not answer for any trouble, as the people had been worked up to a state of uncertainty. I reassured a well-dressed Arab who addressed me, and asked him why the need of hurry? and added that presently I should require breakfast. At once a man was despatched to prepare breakfast for His Excellency.

Then suddenly round the corner appeared about 50 Turkish soldiers in file, led by their Officer. It was with the utmost relief that I saw them turn the corner after they had marched past me, appearing to ignore my presence there.

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Then another Russian woman, about 60 years old, came forward out of the crowd and solemnly gave me an offering of a newly baked cake. This woman, it was whispered in my ear, had been starving for many days. She would wish to show, in this form, her gratitude for being delivered out of the hands of the Turk by the British.

I bowed, broke a crumb of the warm cake, and placed it in my mouth, handing her back the food, which caused a murmur of approval from the crowd.

Still no British came.

Finally, after waiting for just on two hours, I whispered to my horseholder to ride slowly past the crowd, then, when clear, to ride hard up the road and to find an Officer of Artillery or Infantry, and tell him of the urgent necessity of having troops at once in the Town.

This he did, and in about 40 minutes General Watson, Commanding 180th Infantry Brigade rode down with Colonel Bayley, and an escort consisting of one of my Sergeants and 6 armed gunners with two Subalterns of Artillery, amidst cheers from the expectant and happy mob.

The welcome we received at all hands was a sincere one.

"Is it really true that we shall be under British Rule? God be praised, etc., etc."

A few minutes later, the 53rd Division swung up the Bethlehem Road.

I handed over the Post Office to the Military Police of 53rd Division, then remindful of my breakfast, rode away to a rich Arab's house where a sumptuous meal was rapidly eaten in the presence of probably 20 relations of the owner, including a Grandmother and many grandchildren and aunts, most of whom had for days been hiding in the cellars and even caves. Indeed, many friends met outside the Post Office whilst I was there, who had been in hiding for 30 days, and fell on each other's necks in their undoubted gratitude to God or to the British, or possibly to both for their delivery from the Turk and the damp caves.

It was not over yet, because as I left the Arab's house, a shrieking Nun rushed at me, imploring help, saying in French that Turkish soldiers were ransacking the Church opposite the Nunnery, which was also threatened she said.

So I rode on, and found four Turks in the act of filling a cart of Church stuff. They threw up their hands (they were unarmed) when they saw me, and I marched them off, riding back and handing them over to the Infantry Officer. Afterwards, with the help of this Officer, I placed guards on the Church, Nunnery, and other buildings near by.

Sergeant Lawrence, one of my Nos. 1 had formed one of the party to come down with General Watson, and when I sent him back at Watson's request to bring up hurriedly one Infantry Company, he met on his way at the corner of a small street, 12 Turks unarmed; these he took charge of, signing to them to remain where they were until he returned! This they did, and a little later were marched off by the Company.

This totalled 16 prisoners.

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I rejoined my Battery just as we had orders to move North, and at the outskirts we dropped our trails and shelled the ridge to N.W. of the Mount of Olives, where for a time, the Turk offered stubborn resistance—meeting bayonet with bayonet.

From the guns we could see the Turks running along the wall, behind which they attempted to reinforce. We shelled the wall at short range, heavily with H.E. and low bursts of shrapnel, whilst the Infantry advanced up the slope. A pretty fight.

During that perhaps rather difficult time in Jerusalem, one, Issa Mousabek, a Syrian, considerably assisted me as interpreter.

It was with his kindly help that I was able to reassure the many worn and anxious faces about me.

The Deputations of old creatures, Arabs, Jews, Syrians, hysterical women (some German), men of importance, many of none; to all their anxious enquiries as to the safeguarding of persons and property, I answered that from now they were under British Rule—there was no need for anxiety; British Rule was a fair and just one, no harm would come to them and theirs.

One could see the instant relief in their tired faces—even tears of gratitude.

Another Account.

BY TEMP. MAJOR F. R. BARRY, M.C., R.F.A.

On 8th December, 1917, I was commanding 413th Battery, R.F.A., (4·5″ Hows.). On that day we advanced together with C/301 Bde. R.F.A. (Major W. C. Beck) under the command of Lieut.-Col. G. G. Thatcher, D.S.O., R.A., to a position approximately East of Lifta in support of the infantry.

In the evening a successful attack was made on an objective, and this position was held during the night. Just before dark Major Beck and myself registered points from this position in order to assist the infantry in the event of a counter-attack. The night was quiet but at dawn I saw a good deal of movement among buildings some distance in front, and opened fire, but after a few rounds discovered that the movement was among natives.

Nothing further occurred and all was quiet. At about 8 to 8.30 a.m. Major Beck telephoned across to me asking would I join him in a reconnaissance forward to ascertain the situation. I agreed, and we met and started off. We proceeded along the road Eastwards and after walking about 10 minutes saw a large procession with white flags coming towards us. We halted, while an interpreter came to us, informed us that the procession consisted of the Mayor of Jerusalem, the Chief of Police and others, and asked us to see the Mayor immediately as he (the Mayor) had orders to make an immediate

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surrender of the City. We thereupon went to the Mayor, who greeted us cordially, shook hands, and asked that we would accept the surrender of the City. Major Beck explained that we were junior officers only, without authority to act in the matter. The Mayor, however, insisted that his instructions from the Governor were to surrender the City to the first British Officer encountered to obviate bloodshed and material damage, and he asked that we should communicate immediately with the C.-in-C. This we agreed to do as soon as possible, and after further cordial handshaking we returned to our batteries, and Major Beck reported the whole matter to our Divisional Artillery H.Q.

Two infantry sergeants were present during the interview.

With the procession was a Mr. H. L. Larssen and another American gentleman both from the American Colony, Jerusalem. They expressed intense pleasure at the capture of the City by the British, and Mr. Larssen took a photo of a group consisting of the Mayor and other officials, the two infantry sergeants, Major Beck and myself. This has however since been destroyed by order of G.O.C. the division.

The Mayor died some few weeks later of pneumonia, and Major Beck was unfortunately killed by a hostile aeroplane bomb in March 1918.

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ARTILLERY TRAINING.

COMMUNICATED.

THE ACTION OF ARTILLERY IN CLOSE SUPPORT OF ASSAULTING BATTALIONS.

1. The fighting throughout August and September 1918 has confirmed previous experience regarding the vital necessity for closely supporting the advance of the leading infantry with field guns. These guns must come into action at short ranges, and therefore, during periods of TRAINING infantry battalion commanders must have practice in working with field guns and learn how to employ them to advantage.

These lines are written to help battalion commanders and artillery SECTION commanders to combine together for the destruction of enemy machine guns and anti-tank guns. But no paper can be instructive unless its suggestions are practised with actual guns. Therefore battalion commanders should arrange either a field day or a demonstration which will show their officers a section of guns actually working with infantry on a set scheme.

2. Sections of 18pr. batteries rather than single guns should be allotted to assaulting battalions and thus the organization of batteries is maintained. The guns detailed for this immediate support should not ordinarily be included in the "barrage" artillery but should be limbered up ready to advance when battalion headquarters move forward.

3. Before a battle or field day the battalion commander must EXPLAIN to the officer commanding the forward section what dispositions and plans of attack he has made. He should then DEMONSTRATE what he has explained.

4. The battalion commander should not tie down the commander of the artillery in immediate support but give him a free hand after the EXPLANATION.

Although the battalion commander might prefer to have his "gunner" sitting in his pocket, this procedure will be useless if the gunner is then unable to command his guns and *observe their fire*.

5. The battalion commander must keep the artillery informed of the situation of his leading troops by every means at his disposal. It takes two to co-operate and the artillery commander should not be dependent on what he can find out for himself. On a field-day definite situations should be arranged to illustrate this point with machine guns or dummies to represent the enemy. The artillery commander must learn to lift or cease fire whenever the infantry rush the hostile centre of resistance. He must therefore ascertain the whereabouts of this particular body of infantry.

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6. Care should be taken to send messages which will be of value:—*e.g.*, "We are held up by M.G. fire, can't you knock them out?" is a futile message. Whereas "A M.G. is holding us up. It is visible from cottage at N.E. corner of "Y" village and firing from north end of hedge 200 yards west of "X" village" would help the gunner and enable him to engage the target quickly. Practice infantry officers in sending reasonable messages to the guns.

7. A section of 18-prs. acting in close support of advancing infantry carries with it 176 rounds of ammunition per gun; expenditure cannot therefore be on the lavish scale to which we are accustomed in trench warfare, and anything in the nature of a "barrage" is out of the question: the guns should be used as weapons of opportunity.

8. Guns advancing in close support must not absolutely limit their action to the support of particular units; this simply places them in "blinkers."

The most troublesome M.G. fire often comes from a flank opposite the front of some other formation. If opportunity offers, therefore, the artillery commander should engage any definitely located target, even though it may not be giving trouble to the particular troops whom he is supporting.

In this connection advanced guns must be prepared to take on any hostile guns which impede the advance of our tanks. This protective duty as regards the tanks forms one of their most important functions.

An additional officer with the section would be a great help: in any case an artillery N.C.O. should be trained as an observer for fleeting targets.

9. Three essentials for the commander of artillery in close support:—

(1) To hit, and to hit quickly.

(2) To know what to hit and when to hit it.

(3) To recollect that the target will not wait for him and may hit him back.

Therefore he must act wlth lightning RAPIDITY and must realize that it is an unforgivable crime to do nothing, sit still or wait for orders. He requires TRAINING like everyone else.

10. The guns should be controlled by voice or through short lengths of telephone wire.

With this in view O.P's. should be chosen *first* and gun positions after. Semi-covered positions may often be suitable. Positions in the open which have to be occupied under M.G. fire should not be chosen except in case of necessity, as the vulnerability of the horses may cause the guns to become immobile and therefore useless for the rest of the day. Great liberties can be taken in choosing gun positions in moving warfare and any *sealed pattern battery position* should be avoided.

Before the enemy can locate battery positions he usually searches *the most likely places* and is apt to ignore guns in action in flat open country even when the positions are not flash proof.

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The artillery commander's attention should be drawn to section 198, para. 9 "Field Artillery Training" which indicates a method known as "direct for line, indirect for elevation." This method will probably prove useful for the purpose in view, but no method which KILLS THE ENEMY should be neglected.

11. An O.P. from which the progress of the advance can be *clearly* seen offers the best solution to the problem of *how*, *when* and *where* to apply fire to advantage, and also of how to keep oneself informed of the situation.

Battalion commanders should be trained to choose their headquarters in the vicinity of this O.P. and at every subsequent advance be prepared to bound from O.P. to O.P. Within certain limits the position of these O.P's. can be determined beforehand from the map.

12 If information is slow in coming, if the situation is obscure, if visibility is bad from any cause, the artillery commander must send a mounted patrol to obtain *and send him* information.

13. Guns in their advance must take advantage of the ground so as to save casualties to men and horses.

14. Isolated machine gun nests when located are best taken on by single guns of forward sections run up for the purpose. Gun detachments should be trained to man-handle these single guns over rough ground.

Should the position *not* be definitely located, or the existence of several M.G. nests be thought probable (as for instance behind hedges, in houses, etc.), a definite *area* not a *fixed point* should be engaged with section fire. A searching and sweeping fire of H.E. with 106 fuze, within the limits of the suspected area, is effective.

M.Gs. behind parapets, walls, etc. should be taken on with H.E. Delay Fuze.

Against single clearly visible M.Gs. in the open, the best and quickest results are obtained by the use of shrapnel.

15. Although sections only have been dealt with, there are also occasions when complete batteries should advance behind the leading infantry, especially when the latter is advancing on a wide front. In this case it may be advisable for the battery to work with its sections "dispersed." Consequently batteries should be trained in this formation.

16. The moral effect of artillery advancing boldly in support of the infantry, will decide the issue when success or failure hang in the balance. Therefore we must train the two arms to work together.

17. If the officer commanding the troops appreciates the right moment for the advance of a portion of his artillery and fails to issue orders accordingly, he is to blame.

If the commander of the artillery in similar circumstances waits for directions from superior authority, he is to blame also.

Lastly, most emphatically, if one brigade or battery commander hesitates to take the responsibility of advancing when he knows or ought to know that the time has come to do so, he is unfit for his command.

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HINTS ON TRAINING FOR ARTILLERY BRIGADE AND BATTERY COMMANDERS.

Th Training should aim at preparation for Open Warfare on the broad principles laid down in Chapter VII., F.A.T.

1. This article is written to help artillery commanders to train their units when out of the line.

A few points are mentioned and a few hints given, but many more should suggest themselves.

Each battery or section will require particular attention paid to special items—and more time spent on them than on others.

Successful training depends on the trouble taken beforehand, in thinking ahead and in preparing plans. Having prepared them explain them to all ranks. Then demonstrate what you mean before you execute it.

2. Before leaving the line for the training area:

Indents for clothing, equipment, cleaning materials, etc., should be put in well ahead, to allow of their being drawn and issued on arrival.

The organization of the sections and of the battery staff should be looked into and the following questions should be asked:—

Do the section commanders really command their sections?

Do they know what are the powers and the limitations of every N.C.O. and man in their sections?

Do the lead drivers know their drill?—Could they carry on without the help of N.C.O's.? (Teach them formations when in the wagon lines).

Are the signallers able to open up communication quickly between guns and O.P. when the distance between them is short?

Can they semaphore?

See that recent drafts are thoroughly examined. Put them through their gun drill. Pass them out as layers, etc., and thus avoid having to do this when you come out to train.

Officers and N.C.O's. should study the portions of F.A.T. which refer to mobile warfare, more especially VI., IX., and X., to refresh their memories.

The time available is short. Make the most of it. Jot down the points which require special attention. Unless the notes thus made are frequently consulted, some of the items will be overlooked.

Allot the working days ahead, so that before marching out, officers and men may know what time they will have at their own disposal for repeating simple exercises, drills or conferences.

3. Suggested programme for 14 days' training.

1st and 2nd days.

Clean up: refit: issue stores. Lectures by brigade and battery commanders on the duties of section commanders and N.C.O's. at mounted drill and work in the field. Point out the commonest

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errors. Teach subordinates how to teach simple lessons to those under them. Recollect that we all learn quicker through the eye than through the ear.

3rd, 4th, 5th, 6th and 7th days.

The essentials for a good battery are three well-trained sections and a capable battery staff.

(a) Section training under section commanders.—This will include driving drill, map reading, laying, fuze-setting, section gun drill and section drill order.

First of all explain to all ranks in a few words what you are going to make them do under each of these heads. Then demonstrate what you have explained. Next execute what you have demonstrated. Lastly repeat it. Each item or exercise should last less than 20 minutes from the explanation to the repetition, both included. Then do something different, so as never to bore your men.

(b) Points for battery commanders.—Battery commanders will tell their section commanders what to do, leave them to do it, and later criticise. In this way, they will make the subalterns feel that the section is theirs, give them confidence, and increase their power of command.

Battery commanders must restrain themselves from doing the section commanders' work. Why keep a dog and bark yourself? "Battery staff" training under battery commanders or captains.

(c) Points for brigade commanders.—During these days the brigade commander should supervise the work of his own and "battery staffs". He should have at least one "skeleton day" when all the staffs will be exercised on a combined scheme.

He will also be occupied in riding over the training ground and looking into the schemes handed over by the training staff.

He should not supervise the section commanders himself but make sure the battery commanders do so.

"Brigade staff" training under adjutant.

See that all signallers keep "signal discipline" and use the right flags, etc.

8th day.

Holiday.

9th and 10th days.

Battery training. (One day in marching order.)

11th day.

Brigade training. (Marching order.)

12th day.

Ceremonial mounted parade. (Everyone on parade.)
Holiday in afternoon.

13th and 14th days.

Combined training with infantry brigade.

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If no formed bodies of infantry are available get some infantry officers to come and lend you a hand and carry out a couple of "Exercises without troops." Much good work can be done this way.

4. A few points of drill which require practice.

Distance and intervals.—Put the guns in action at 12 yards and at 20 yards. Then take the whole battery back 200 yards and shew the difference, then give the reasons for 20 yards between guns.

Position of the battery leader when the battery is in action.—If he is in front and on the flank of the line of guns, he can't hear or be heard. Try him a little to the rear and on a flank.

Position of the battery leader when the battery is on the move.—The B.L. *will* hug his battery. Drive him out at least 200 yards from it.

Signals (*F.A.T. sect.* 130).—Spend 10 minutes shewing these with the battery mounted at a halt, and make officers and Nos. 1 make these signals correctly, and see that the drivers understand them.

Coming into action.—From line;
From column of sub-sections;
From battery column then sections R. wheel.
Show the position of B.L. to get the battery square.

B.S.M's. party.—Eyes skinned.

F.A.T. section 196, para. 5.—Go through this in billets with the whole battery and make absolutely certain that it is understood: limbers often advance 10 yards instead of one yard, after "Limber drive on."

F.A.T. sections 228 and 229.—Go into the various methods of procedure thoroughly in billets.

F.A.T. section 201, para. 6 (Signals to wagon lines).—Very few nowadays can do the simplest semaphore, and this must be seen to.

Parallel lines.—In closed pits and in trench warfare there is little opportunity of practising this—so DO IT and GO ON DOING IT, till you have got it right.

Map reading.—Small scale maps, 1/100,000.

Resection of position.—Magnetic compass should be the last resource.

Single guns manhandled up forward to knock M.G.s.—Practise this on bad ground and find out the best way to do it.

Practise detaching a section with its complement of signallers, etc. Remember that when a section is detached it requires some fostering care from behind.

Practise taking up a position with one section in "observation", two in "readiness".

Sections in close support of assaulting infantry. When working with an advanced guard remember that the direction in which to move is *forward*. Reconnoitre before movement—this reconnaissance should be made by the commander and not entrusted to a subordinate.

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Mounted orderlies.—Can they find their way about?

Officers mounted patrols.—Send them out frequently to collect information and send it in.

Practise casualties on every drill order parade so that the work will still go on with reduced numbers.

It is very necessary that all members of the battery staff should be inter-changeable and know each other's duties. In an advance they may become strung out. Some may be missing; others may have lost their way, and the work must be carried on by those who remain.

Practise the action of a super-imposed brigade joining in a barrage but detailed to advance in support of the infantry after they have reached a certain objective. Drill your brigade in getting off the mark QUICK.

Train the batteries to select a further position 2,000 yards or more in front of where they are in position. If there is time and opportunity put some ammunition there also, ready for the next "bound".

Take the wireless mast out on brigade days and PUT IT UP.

5. General.

Hold an opening conference. Don't be alarmed at the word—it only means a "talk." Take your officers and men into your confidence and tell them all about what you intend doing—tell them why discipline is essential, why training is necessary, point out that all military efficiency is nothing more than the exercise of sound human intelligence, etc., etc.

Go on holding these "talks" throughout the whole period of training. Make them as informal as possible.

Work to a time table each day.

Have quick parades—but always remember there is a difference between being quick and being in a hurry.

Stimulate everybody's interest by telling them exactly what is going to be done at each exercise, just before you start it, and why. Get your men interested—they will then PLAY UP.

If mistakes have been made, point them out, then repeat the exercise. It is by making mistakes that we learn best how to avoid them.

When a drill order is discussed afterwards, make sure the *drivers* hear what is said.

Make explanations simple and short.

Don't waste time in discussions or argument. If such are necessary, put them off till the parade is over, then thrash the matter out at a conference.

Make all officers jot down in a note book the mistakes they see and the points they wish to raise.

For brigade and battery parades, make each subordinate commander have some points of drill ready to practise in the course of the day's training. These can always be done. They will quite probably occur during battle, *e.g.*, replacement of ammunition and of casualties: small moves of a section, or of wagon lines to avoid shell

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fire: junior N.C.O.s taking the place of senior N.C.O.s. Have this ready before the parade begins. Work it all out beforehand and report on the result afterwards.

Avoid exercises which can be done equally well in trench warfare.

When at drill insist that rigid discipline is maintained—that such orders as are given are clear, definite and emphatic, and that officers and men in the ranks work steadily, smartly and with accuracy.

Pay attention to "turn-out" always. Thus will men take a pride in themselves and in their battery.

Make at least one battery march past the brigade commander on its way to or from drill each day. Look to your march discipline —outsiders judge you entirely by this.

See that any attached young officers learn stable management, they don't get a chance at home. Teach them to instruct and above all to command. You can't command without having something *to* command. Therefore give them some men to look after.

Have notice boards fixed up so that all ranks can see what is going on. Organise the men's games and join in them. Arrange competitions between sections or sub-sections. They increase keenness and pride of the men in their own show, for instance—

Order each section into action separately: allow half an hour—then "Stand clear"—Marks for "Slits" well dug; lines of fire checked, good A.P.s chosen, good communications, ammunition dumped, wagon lines well concealed and advantage taken of natural cover.

Or, check the time sections take in coming into action from the order to advance until all teams are clear.

Again, hook in, get clear away off the position, take the time and disqualify any sub-section whose team is wrongly hooked in, etc., etc.

Every battery should have a scheme or two ready to put into operation in the event of wet weather. Brigade and battery commanders should also have lectures ready. Description of recent battles, more especially those in which the brigade has taken part. The men will be interested to hear what was the average number of rounds fired daily per gun and how many tons of metal this amounts to, etc., etc. They will also be delighted to hear any story you can tell them of another battery's success in battle.

Point out the mistakes made and the possible alternatives.

Extracts from newspapers will brighten up a lecture and bring your points home.

6. Training has but one end—to kill the enemy. Success in this matter is attained not only by good shooting but by determination—if determined to kill the enemy, ways and means of doing so will readily suggest themselves.

The best way to learn is to make mistakes and have them pointed out to one.

Never discourage the man who is trying to learn.

Encourage people to ask questions, listen to them patiently and answer them to the best of your ability even though you may think them futile.

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The men are very human and quickly respond to the human touch.

You are taught in the riding school how to "make much of your horses"—apply the same treatment to your men occasionally—they will appreciate it.

A WET DAY IN THE TRAINING AREA IN FRANCE. (ARTILLERY.)

How a Battery can use it.

On a wet day a Battery Commander is often at a loss know what training to carry out.

Instruction can, however, be given in billets—and be made both interesting and amusing, and this is written to help such instruction.

When the weather turns out too bad for outdoor work the first thing which usually comes to mind is—LECTURE. A lecture, however, requires preparation. Although every officer should be able to explain points of drill or training to his men, an explanatory lecture is of little use unless followed by demonstration and execution, and these are difficult to carry out indoors in a confined space.

For instructional purposes something more is needed.

Try and evolve something new. Carry out instruction on common-sense lines so that it appeals to the men's reason and does not become a feat of memory. Don't spin out work which can be done in twenty minutes so as to cover an hour. The learning of a new thing is always interesting—the practising of an old one is apt to be monotonous.

Bring the eye into use as well as the ear.

This can be done in many ways. With thought and ingenuity much can be taught even in a limited space with material lying ready to hand. *BUT* in order to make good use of a wet day forethought and pre-arrangement are necessary.

All likely billets, barns, sheds, etc., should be marked down and a scheme drawn up ready for the first wet day.

1. Training of the Eye.

WHAT THE EYE DOESN'T SEE THE MIND DOESN'T GRASP.

It is generally possible to find a barn or shed from the open door of which some country can be seen. If there is a view of a hillside so much the better.

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(a) Clock Code.

Put up a board a certain distance off marked in degrees subtended at that distance, or chalk up the figures on an adjacent wall. Make each man find out for himself the number of degrees covered by his knuckles, fingers, outstretched hand, etc. Then point out objects in the distance by clock code from a reference point. Make each man in turn spot the object you wish to point out.

Officers and N.C.Os. use graticuled glasses to check these angular measurements.

(b) Aiming Points.

Choose objects as "Aiming Points"—make the men identify them—then explain why they are good, bad, or indifferent.

(c) Eye for a Country.

Give your men five minutes to look at the country in front of them and remember all they can see. When time is up they turn round and write down what they have seen. This teaches them to use their eyes intelligently, exercises their memories and brains, cultivates an "eye for country" and compels them to note essentials, not trivialities.

(d) Natural Features.

In order to make men observant, point out the difference between the various trees they see in front of them. Trees are common objects and learning to distinguish one from another practises and quickens the eye and improves power of observation—the ability to distinguish natures of trees at a distance is often a help in singling out landmarks when finding a way across country, or to layers in picking up a target.

Many means can be found of training the men's powers of observation and developing in them the "Hunter's Instinct". Explain the appearance of various natures of crops, of hedges, why damage is caused by riding over clover and root crops, that every stack in a field is not necessarily a *hay*stack, etc. Point out that it is not only necessary to give *the names* of things but also to *describe* them. For instance, "dyke" may mean either a ditch or bank. Some of the men themselves, game-keepers, farmhands, etc., will give this information to the others.

(e) Imaginary Targets.

Point out lengths of hedge, banks, etc., assume they contain HUNS, and ask N.C.O's. and men what orders they think ought to be given in order to KILL those HUNS with their guns.

(f) Compass.

The use and abuse of the magnetic compass can be taught, and how to identify points of the compass by the sun, stars, a watch, a church, trees, etc.

The programme should be varied and only a short time spent on each lesson. Incidentally, sharp-sighted, quick-witted men may be discovered who will train on as "look-out" men.

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2. Local Geography.

Teach your men the names of the topographical features in the neighbourhood. Ask them the names of the nearest villages and the distances to them, etc. "Where is the village post-office, forge, Mairie? Is there any place suitable for watering horses other than the place you are accustomed to go to?" Tell them they must keep their eyes open as by the *next* wet day you will expect them to answer questions of this sort readily. They will then begin to notice things unconsciously and develop a "bump of locality".

3. A Miniature Landscape.

(a) A miniature landscape can be devised by means of blankets, waterproof sheets, etc., spread on a couple of tables, undulations in the ground being shewn by means of mess-tins, steel helmets, bricks, sods, etc., placed underneath. A handfull of grass will make woods and hedges, some broken brick and pieces of wood will represent villages, roads can be produced by means of light coloured earth or chalk, trenches by pieces of string, and so on. With a little cotton wool at the end of a wire or stick the burst of shell can be represented. Fire can then be directed on to any point in this landscape and errors in ranging, wrong sequence of orders, and the difficulties of an F.O.O. can be exemplified. With ingenuity targets in motion can be indicated, necessitating rapid decisions being made and quick orders given out.

Field glasses should be used the wrong way round.

(b) Carry out exercises in "Fire Tactics." Base them on a simple Tactical Scheme, *e.g.*—"Z Artillery Brigade, of which X Battery forms part, is ordered to support an infantry battalion in their attack on village V." Then carry on—Brigade Commander, represented by 'A', gives his orders to O.C., X Battery 'B'. 'B' gives instructions to the Battery Leader 'C'. 'C' passes necessary orders to a section commander 'D'. 'D' thereupon calls on a N.C.O. 'E' to act as No. 1. 'E' gives his orders to an imaginary gun detachment.

In every case ORDERS must be properly given and properly passed. The officer conducting the scheme makes criticisms and corrects mistakes.

4. Laying and Fuze Setting.

If the gun park is under cover, or if a shed is available under which a couple of guns can be placed, *laying* can be carried out. The squads should be just big enough to keep every man employed and *no more*. Spare men hanging about behind the guns are a sign of bad organisation. Never make men who are experts do the same work as those who are backward. Always have men either *hard at work*, or sitting easy and smoking.

Fuze setting can be carried out anywhere, and young gunners can be taught all the markings on the different classes of ammunition.

5. Brain Exercises.

(a) The old parlour game of passing a message from man to man and seeing the result at the other end is a useful form of

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training the memory and intelligence and can be carried out in any billet. Mistakes in any message must always be traced back to the individual at fault.

Give a simple message to the whole of the men—see that they all understand it. Then warn them that it may be asked for at any time during the day from anyone present.

(b) Place a number of different articles with a cover over over them. Remove the cover for a short time, then replace it. Every man to write down a list of what he has seen—having done so, he then checks it with the actual articles.

(c) Make one man stand up for 30 seconds. Rest of men then to describe his hair, eyes, badges, etc.

6. Rifles and Lewis Guns.

Training in the Lewis gun and aiming exercises with rifles can always be carried out indoors.

This should be reserved specially for wet days.

7. Manœuvre.

Driving Drill and all manœuvre formations can be practised by making use of small wooden blocks, marked or, preferably, painted in different colours, to represent section commanders, Nos. 1, battery staff, 6 horse teams, gun limbers, guns, wagon limbers and bodies, etc.

Blankets can be rigged up to represent a field with only one entrance. Markers are placed to represent the flanks and the dummy battery can be manœuvred into action from line, battery, column, column of route, etc., etc.

Every man is given a block representing himself. This he has to put in its place according to the order given.

Ceremonial formations, ranking past by sections, by single file, and forming up "at order" or any movement involving accurate drill can be gone through, the drivers being shewn their proper distances and intervals at any stage of the proceedings.

The Nos. 1 can do this with the men of their own sub-sections.

All this will demonstrate to the men through their eyes, their difficulties will be discovered and cleared up, and the next time the movements are executed in the field the value of this "game" will be realised.

BUT don't let people say *what they propose to do*—MAKE THEM GIVE THE ACTUAL ORDERS.

8. Miscellaneous.

Instruction in folding of saddle blankets, rolling of waterproof sheets and nose bags—saluting by drivers (sitting across a bench)—the A B C of map reading and reconnaissance, etc., can all be given under cover.

Give the drivers a demonstration of how to "pack" ammunition.

Some place under cover in which to practise hooking-in and unhooking of teams can often be found even if there is only room for a limber and a pair of wheelers.

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9. Communications.

Signallers can be employed under the A.1's. or Brigade signal officer in telephone or buzzer. This must never be allowed to lapse into sending paragraphs out of old newspapers and so become dull meaningless routine.

The brigade signal officer should have a scheme ready which will employ Brigade H.Q. and the battery signallers in conjunction. He can wire up the different battery offices to Brigade H.Q., and practise sending and receiving messages at high pressure with the more backward men. If the *best* men are put on, the scheme is sure to work and does no good. Let mistakes be made but point them out afterwards.

By working out a scheme beforehand it should be possible to send messages through by semaphore, keeping the men out of the wet and using several transmitting stations.

10. Exercise for Subalterns.

Let the Battery Commander call up his section commanders in turn and say:—

> "I am sending you off with your section on detached duty. You will be away at least 4 days, perhaps more. You will be marching and fighting the whole time. You will be completely on your own and will get no help from anyone in the battery, so your section must be self-contained. What are you going to take with you? Get hold of your Nos. 1 and anyone else you like in your section, tell them all about it and talk things over with them. Write down notes of what you propose doing and then come and let me know. If you have any questions to ask be quick, as I am off in 5 minutes from now."

The B.C. then sees all section commanders, Nos. 1 and other N.C.O's. at a specified time—makes them compare notes amongst themselves and himself criticises the schemes.

A small competition should be held to see which section produces the best scheme. This introduces a spirit of emulation.

11. First Aid.

First aid demonstrations can be given by the Medical Officer—What to do and what not to do. Similarly the Veterinary Officer can give lessons in the treatment of injuries to horses.

12. Discipline.

Battery and Brigade Commanders should be ready to talk on discipline, the necessity for smartness at all times in bearing and turn-out, the maintenance of a soldierly spirit and pride of Regiment, etc.

13. Lectures

Leaflets of the Active Service Army Schools Series are now available.

These are lectures in skeleton, and give the main headings under each subject. Any officer, with these as guides, can lecture to his men: and many of the men will be found who can talk with knowledge on their own subject—given the assistance of these leaflets.

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The subjects treated include:—

1*a* War Pensions and allowances—What the State is doing for the wounded.

1*b* The care of Disabled Pensioners—What the State is doing for the disabled.

2. The Lichnowsky Memoirs—Germany's guilt in the War.

3. The New Franchise—Who is now entitled to the vote.

4. The American Effort—What America is doing and has done in the War.

5. Agriculture in the Future—The Possibilities of "Back to the Land."

7 Women in Industry after the War.

8. The Achievements of the British Navy in the War,

and others now in course of preparation. These include Notes on Historical Events, *e.g.*, famous British battles connected with places in the area of the British Army.

Copies of the above Notes for lectures can be obtained direct by writing to:—

G.S. Training, G.H.Q.

In addition, there are available copies of reports on the opening for disabled soldiers in 17 different trades—Carpentry, keeping of fowls, bees, rabbits, pigs, market gardening, etc.

In the Divisional libraries are books of reference on a number of subjects which can always be obtained.

14. F.A.T.

All battery officers should re-read Field Artillery Training, Chapters VI.—VII. (less Sections 150, 151, 177, 178 and 179), VIII. and IX. (less Sections 203 to 206, 226 and 227)—an Artillery officer can find no better employment for his spare time on a wet day. He will always find something he has overlooked or forgotten.

(To be continued.)

ARTILLERY GRAPH.

By Lieut. H. J. Fisher, Australian Field Artillery

Explanation of Graph.

This simple scheme will be found useful for controlling the fire of any Battery of Artillery, more especially designed to facilitate more rapid and accurate shooting when guns are not in line and at irregular intervals.

Method of Use.

By means of a drawing pin, pivot the scale of yards with Concentration table below so that "O" is directly over the position of the Pivot Gun on the Graph.

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Swing the scale until the top edge cuts the Degree Arc on left edge of Graph at the number of Degrees Right or Left of Zero at which it is required to shoot, then—

(a). The figures on the scale where the circles drawn through each gun cut it show the number of yards for which Concentration on the Pivot Gun has to be made. The Degrees and Minutes Concentration at any range are given under each 10 yards.

If it is required to concentrate on any other than the pivot gun, read the number of yards on the scale where it is cut by the circles passing through the gun on which it is desired to concentrate and also where the other gun or guns cut the scale. The difference in yards can then be found and concentration obtained from the table below that figure.

(b). The Angle subtended by the Battery or by any two or more guns at that Switch is the number of degrees and minutes due to the amount of yards between the points where the circles passing through the flank guns cut the scale.

(c). To evenly space rounds, open out or concentrate the flank guns to the extent of the target and give more Right or more Left to each other gun to bring them all to an even amount of yards distant from each other.

(d). The Difference in Range between that of the Pivot Gun and any other gun is the distance in yards from the position of any gun on the Graph to the point where the circle passing through that gun's position cuts the upper edge of the scale.

This distance should be measured from each gun's position to where its circle cuts the Zero Base and the lines drawn at each 10 degrees Right or Left of the Zero Base, the results being recorded for ready application.

The Graph is based on the assumption that lines of fire are laid out Parallel, with the Pivot gun on the Zero Point.

Parallelism of Aiming Posts may be checked by firing Time Shrapnel with false angle of sight at various switches and ranges, the distance between bursts as measured at the battery being in accordance with the figures shown on the concentration table for those switches and ranges.

Method of Preparing a Graph for any Battery Position.

1. On a large sheet of paper—foolscap size will usually do—accurately plot to a scale of 1/1000 the positions of all guns and the direction of the Line of Fire of the Pivot Gun to the Zero Point.

2. Draw a line at Right Angles to the Line of Fire of the Pivot Gun on the Zero point through the position of the Pivot Gun. This we will call the Zero Base.

3. Draw lines at every 10 degrees Right and Left of the Zero Base, according to the extent of switches Right and Left required to cover the Zone of Fire.

4. Using a point halfway between each gun's position and the Pivot Gun's position as centre, draw circles to pass through the position of the Pivot Gun and each gun in turn.

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5. With the Pivot Gun as centre draw an arc near the edge of the paper and mark it in degrees Right and Left of the point where the Zero Base cuts it.

6. On a straight edge of a piece of white cardboard or stiff paper mark off a scale of yards to the same scale as that of the Graph. Number each tenth yard and pivot this with a drawing pin with "O" over the position of the pivot gun.

7. Under each of these ten yard marks on the scale copy a table of angles subtended by that number of yards at every 500 yards range at which it is required to shoot.

The best way to accurately plot the positions of guns and Zero Line of Fire is to set the Dial Sight of the Pivot Gun at Zero on the Line of fire, measure the angles to each other dial sight in turn and also the actual distance of each gun from the Pivot Gun. These measurements may then be plotted to scale on the paper.

If the position of each gun is accurately known and shown on a large scale map the Graph may be enlarged from the map.

Other methods employing a Director and Sighting Rule will suggest themselves.

Theoretical Note.—As the lines of fire are parallel, the Base Lines move Right or Left of the Zero Base as the Line of Fire moves Right or Left of the Zero Line of Fire. The angles made by the line of fire with each of these base lines in turn are all right angles, and therefore the lines of fire of each gun at all switches will cut these base lines at points on the circumference of a circle. (This follows from Euclid's Propositions "That angles in the segment of a circle are all equal", and "That angles in a semicircle are all right angles).

Examples—(1). Target—Cross Roads 24 degrees Right, Range 3500 (measured from No. 1 Gun).

No. 2.	24	degrees	20	mins.	Right,	3525	yards
No. 3.	25	„	5	„	„	3550	„
No. 4.	25	„	30	„	„	3575	„
No. 5.	26	„	20	„	„	3500	„
No. 6.	26	„	55	„	„	3500	„

(2). Target—Trench 40 yds. long, 16 deg. left, Range—5200 (measured from No. 1 Gun).

No. 2.	15	degrees	50	mins.	Left,	5200	yards
No. 3.	15	„	25	„	„	5200	„
No. 4.	15	„	5	„	„	5200	„
No. 5.	15	„	10	„	„	5100	„
No. 6.	14	„	50	„	„	5100	„

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Issued To face page 316.

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Contents of R.A. Journal, January, 1919.

An Appreciation. Genl. Sir Robert Biddulph, G.C.B., G.C.M.G., Colonel Commandant, Royal Artillery. Master Gunner, St. James's Park. Born 26 Aug., 1835. Died in London, 18 Nov., 1918. 317

Remarks on the Vice-President's Appeal to the Members R.A.I. By Lieut.-Colonel H. W. L. Hime. 323

Echoes from the Mess Table—and elsewhere. By "Henry Clay" 325

What is a Nomogram? By Lt.-Col. R. K. Hezlet, D.S.O., R.A. 330

Tactical Exercises Without Troops. By Major-Genl. H. C. C. Uniacke, C.B., C.M.G. 334

The German Invasion of England. Xth to XVIth Centuries. By Brig.-General F. G. Stone, C.M.G. 338

Artillery Training. Communicated. (Continued from No. 9, page 314). 350

Authors are alone responsible for facts and opinions expressed in their papers.

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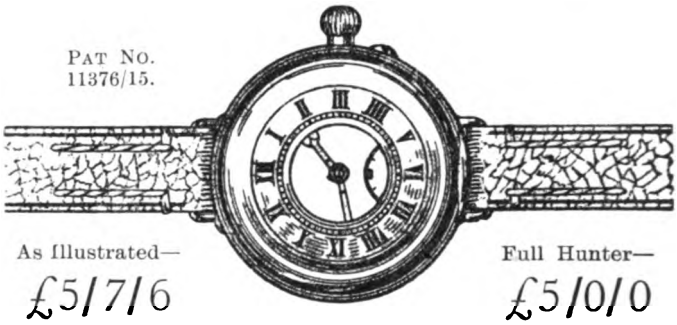

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AN APPRECIATION.

Genl. SIR ROBERT BIDDULPH, G.C.B., G.C.M.G., Colonel Commandant, Royal Artillery. Master Gunner, St. James's Park.

Born 26 Aug., 1835. *Died in London, 18 Nov., 1918.*

BY the death of Sir Robert Biddulph the Royal Regiment of Artillery has lost not only its Master Gunner and senior Col. Commandant, but one of the most distinguished of its members who maintained an active interest in its doings and achievements up to a few months of his death.

He was commissioned from the R.M. Academy in June 1853 as 2nd Lieut. R.A. before he was 18 years of age, and the following year saw him in the Crimea. Until the fall of Sebastopol he served in 1/11 R.A. (W. Field Battery) commanded by Capt. R. G. Barker. He was then transferred in the Crimea to I Troop R.H.A., and from March 1856 until the evacuation was Adjt. R.H.A. to Col. D. E. Wood. He took part in the battles of the Alma and Balaklava, Siege and fall of Sebastopol and Expedition to Kertch.

Lt. Biddulph embarked for India in Aug. 1857 as Adjutant R.A. in India, and served at the Siege of Lucknow as D.A.Q.M.G. Royal Artillery on the Staff of Sir Colin Campbell and, later on, as D.A.A.G. Oude Field Force under Sir Hope Grant. His services during the Mutiny also included the actions at Kali Nadi, Jamo, etc.: and he was twice mentioned in despatches.

In 1860 he was promoted "Second Captain" and accompanied Sir Hope Grant to the China Expedition of that year as Military Secretary, participating in all the principal actions of that campaign including the capture of the Taku Forts and surrender of Peking.

Biddulph had thus been practically on continuous service in the field for seven years and had taken part in three campaigns in widely distant theatres of war. He now obtained an important start over his contemporaries in the race for military advancement by being given the Brevet rank of Major for China in 1861.

He returned to India (until 1865) with Sir Hope Grant as Military Secretary, on the latter being appointed C.-in-C. in Madras, and was gazetted Brevet Lt.-Colonel in Jan. 1864, this being a post-dated brevet for services in the Mutiny for which a reward had been withheld on account of Major Biddulph's short service.

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Nearly 5 years after becoming Lt.-Col. in the army he was promoted to First Captain in the R.A. and Regimental Major in 1872!

In 1868 Lt.-Col. Biddulph served as Asst. Boundary Commissioner under the Reform Act of 1867. He was the author of "The letter from a Staff Officer" published by Lord Elcho in Nov. 1870, and he himself later, informed Mr. Cardwell of this fact which shows that army reform had already occupied his mind.

In the same year (1868) he was appointed D.A.Q.M.G. of the Woolwich Command and held the post for 3½ years until selected by Mr. Edward Cardwell, then Secretary of State for War (later, Viscount Cardwell) to be his Private Secretary at the War Office. Here he was at the "hub" of the army; it was the period of the Franco-German War of 1870-1 which of necessity demanded the most careful attention of our military leaders, and Biddulph was able to be of important service to his eminent chief during what was undoubtedly the most interesting and radical epoch of army reform, embracing as it did, the Short Service and Army Reserve Act of 1870 and the formation of Colonial military forces to release the Home army which up to that time had been widely distributed through the Colonial Empire. Other notable enactments of the Cardwell *régime* were the Abolition of Purchase, Localization of the Forces, Affiliation of the Militia and Volunteers to the regular army, etc.

This deeply interesting period is admirably and lucidly dealt with in Sir Robert Biddulph's notable work "Lord Cardwell at the War Office" (John Murray 1904), for the compilation of which the author had the privilege of perusing Lord Cardwell's papers and other State documents.

Having become Bt. Colonel in 1872, Biddulph was appointed A.A.G. at Headquarters in 1873 where he remained for five years until ordered on "Special service" to Cyprus in 1878; he became Major General in 1883.

In 1882 Sir Garnet Wolseley offered Sir R. Biddulph the post of Chief of the Staff, Egypt, but his duties in Cyprus (as High Commissioner) prevented his acceptance of it.

Sir Robert was a man who never had long to wait for an appointment, and after eight years in Cyprus he once more reverted to the War Office, in 1886, as I.G. Recruiting, until 1888 when he was transferred to be D.G. Mil. Education for another five years.

In 1887 he was for four months Q.M.G. to the Forces, and again for the first nine months of 1893 in which year he became Governor and G.O.C.-in-Chief of Gibraltar where he was granted an extended spell of office until July 1900. He became Lt.-Genl. in 1887, General in 1892 and Col. Commdt. R.A. in 1895. In 1904 he was appointed an Army Purchase Commissioner.

For his services in the Crimea Sir Robert Biddulph received the medal with three clasps, the Turkish medal and the 5th Class of the Medjidieh; for India, the Mutiny medal and clasp; for China, the medal and 2 clasps. He was created a C.B. in 1877; K.C.M.G., 1880; G.C.M.G., 1886; K.C.B., 1896; G.C.B., 1899.

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On the death of F.M. Earl Roberts, V.C. in 1914, His Majesty the Colonel of the Regiment conferred on Genl. Sir R. Biddulph the historic and honourable appointment of Master Gunner, St. James's Park.

It is evident that in a memoir of this kind which is primarily intended for his brother officers in the Regiment with which his long and distinguished military career was associated, space will not admit of more than a brief summary of Sir Robert's services as a Colonial Governor which were equally brilliant; but this notice would be incomplete were I not to touch on his work at Cyprus and Gibraltar.

As already mentioned, Col. Robert Biddulph was sent on Special service to Cyprus in 1878, attached to the Army of Occupation under Sir Garnet Wolseley and very soon became immediately concerned with the Civil Administration of the island.[1]

In July 1878 he proceeded to Constantinople as Commissioner for settlement of the amount to be paid under the annex to the Treaty of Berlin of 1878, by which it was stipulated that Turkey should receive annually a sum (afterwards known as the Tribute) equal to the average excess of revenue over expenditure derived from the island in the five years preceding the occupation. The investigation was one which called for considerable financial acumen in resisting the wiles and misrepresentations of the Ottoman authorities. In June 1879 Biddulph succeeded Sir G. Wolseley as High Commissioner of Cyprus and had now to face the formidable task of replacing the corrupt rule of the Turk by the enlightened system which characterizes the British method of Colonial government. Every detail to bring the administration up to the standards of Western civilization had to be created *de novo*. How successfully Sir Robert acquitted himself is displayed in the record of his seven years' work in the island.

I propose to tabulate briefly the chief reforms for which Sir R. Biddulph was responsible and it will be seen how carefully and tactfully the essential measures were introduced, nothing being rushed, but quietly and persistently brought forward in the natural sequence of importance.

1. One of his first acts was the withdrawal of the Turkish *caïme* (paper) and *métallique* coinage and the establishment of a new currency on a gold basis which went far to place the finances of the island on a sound footing.
2. The corrupt administration of justice had to be tackled. English Assessors were appointed in the first place to Turkish Courts, to be followed in 1882 by a complete reorganisation of the Courts under English barristers as Presidents assisted by Mahommedan and Greek Christian Members selected from among the local inhabitants.
3. A very burdensome taxation was carefully revised, all farming of taxes was abolished and a direct assessment and collection by Government officials substituted—many vexatious imposts were removed.
4. In 1883, the Legislative Council was reconstituted on a representative basis with a liberal suffrage. Local Self Government was accorded in the chief towns.

[1] I am indebted to Sir George Smith. K.C.M.G., Governor and Commander-in-Chief of the Nyassa Protectorate who commenced his Colonial Departmental service in Cyprus in the same year as Sir R. Biddulph, and whose knowledge of the island and its government is probably unrivalled, for some interesting notes on the work of his former chief, during the seven years of his administration, and I feel I cannot do better than make free use of them.—*J.C.D.*

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5. Roads, harbours, quays and piers were provided, drainage and irrigation works commenced and suitable public buildings erected.

6. The scourge of locusts was combated, education regularised, the island surveyed and a strict conservation of forests replaced reckless depletion.

The good seed thus sown soon bore fruit, and the effects of centuries of Turkish mis-rule, naturally hard to eradicate, yielded nevertheless to Sir Robert's just and wise treatment, and, in the words of Sir G. Smith "he gave to Cyprus all that was most honest "and enlightened in British rule and laid the solid foundations on "which has since been built up the good government of this little "oasis in its vast surroundings of misgoverned Turkey."

His earnest devotion to the interests of the Cypriotes was fully appreciated by them as well as by the British Government and duly rewarded by the Sovereign.

As regards Sir R. Biddulph's service as Governor and G.O.C.-in-C. of Gibraltar, 1893-1900, there must be a considerable number of officers of the Regiment who served under him during that period, and who will remember his just and efficient rule, and the many improvements made on "The Rock" during his tenure of Government House.

Gibraltar being primarily a fortress, the Governor's duties were largely concerned with questions of defence, naval and military, as well as with those connected with a large commercial free port, but at the same time there were important matters with regard to the internal government of the large Civilian community which gave scope to his great administrative ability.

The relations with Spain demanded great tact and diplomacy. The late Mr. Joseph Chamberlain, then Secretary of State for the Colonies, paid a visit to Gibraltar during Sir Robert's administration, and between them the difficult and often strained situation arising out of the everlasting contraband question, was considerably eased.

Sir Robert's experience in Cyprus, and his financial ability stood him in good stead in Gibraltar, and one of the chief Acts which became law in his time, is the Order in Council of 9 August, 1898, by which the legal currency both for circulation and for keeping the public accounts, was directed to be that of the United Kingdom, in place of the unsatisfactory Spanish currency of all dates which had obtained up till then.

The Sanitary Commissioners, under his able lead, were by an improved financial position, enabled to carry out some notable undertakings of great value to the Colony and Fortress, in connection with public works, water supply, drainage, and electric lighting. Military and Naval Works were advanced, and the Commercial port improved. All these matters were carefully superintended by the Governor, who whilst never grudging money for necessary objects, was strongly opposed to wasteful or useless expenditure.

The following tribute to the memory of a former chief has been sent me by one who knew him intimately and loved him:—

"To those who had the privilege of his intimate acquaintance, the fine character of Sir Robert Biddulph presented many points of admiration. His great ability, his keen and clear business capacity,

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his ready grasp of administrative and financial problems and the literary facility with which he committed his views and opinions to paper, combined to place him in the front rank of British administrators; while his charm of manner and the ready and sympathetic hearing with which he received all representations made to him endeared him to those who were fortunate enough to look to him for guidance in their affairs.

Sir Robert was a man of strong religious convictions walking in the fear of God, a high example to those around him. His many deeds of charity and benevolence are known only to those who never applied to him in vain.

In the social world around him he was always welcomed as a good *raconteur* with a remarkable memory and a keen sense of humour; while his innate modesty and strong aversion to self-advertisement engaged the respect and esteem of all who knew and appreciated his worth."

Amongst the many Regimental institutions with which Sir Robert Biddulph was connected and in which he took a great interest may be mentioned the R.A. Institution of which he was the senior Trustee. He was also for several years Chairman of the Committee for the revision of Kane's List of the Officers R.A., and the gratitude of the Regiment is due to him for his continuous endeavours to improve the value of the work as an accurate record and to make it as complete as possible, especially as regards the revision of the Short Biographies. His long experience and knowledge of the history of the Regiment derived from personal acquaintance with many of the old officers of Peninsula and Waterloo days was invaluable.

Since the death of Lord Roberts he took the chair at the Annual Regimental meetings, and that of June 22nd 1917, possesses a special pathetic interest from the fact that when acknowledging a vote of thanks Sir Robert said "This is the sixtieth anniversary I have been present at. I feel I am not likely to meet you many more times." It was the last he was able to attend.

He was also a co-opted Trustee of the Kelly-Holdsworth Royal Artillery Trust, and at its first meeting held on 15 December, 1914, he was elected Chairman and remained so until the end. He never missed a meeting of the Trustees nor of the Benefits Committee, and his wise counsel was of the utmost assistance.

General Sir R. Biddulph was son of Robert Biddulph, M.P. for Ledbury, and married Sophia (d. 1905) daughter of The Revd. A. L. Lambert, by whom he leaves a family of 4 sons and 6 daughters. Three of his sons have been serving their country during the present war.

The funeral of the late "Master Gunner" took place on Monday, 25 November, 1918. The first part of the service was taken at St. Paul's Church, Onslow Square; the Revd. H. W. Webb-Peploe officiated, and the choir was formed by girls from the Soldiers' Daughters' Home, Hampstead, of which the deceased was Chairman, and a strong supporter.

The King was represented by Colonel F. G. Blair, A.D.C. and

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there was a large attendance at the Church. The mourners included Brig.-Genl. Harry Biddulph, R.E., C.M.G., D.S.O., son, and his sisters, besides other relatives and many distinguished officers of both services, including several of the Royal Artillery.

After this service, the body was conveyed by motor-hearse to Woolwich, where it was received at a parade of the Royal Artlllery under the Command of Brig.-Genl. R. W. Breeks, C.B., and transferred to a gun carriage for interment in Charlton cemetery. The Cortège, headed by the firing party and preceded by part of the R.A. Band, moved off followed by the mourners, and a large body of Officers, Royal Artillery, the rear being brought up by the troops who had lined the parade.

The Pall-bearers were as follows:—

Maj.-Genl. H. T. Arbuthnot, C.B., General Sir R. McG. Stewart, G.C.B., Maj.-Generals M. H. Saward, Sir D. D. O'Callaghan, K.C.V.O., and R. A. Montgomery, C.V.O., C.B.; Brig.-Generals R. W. Breeks, C.B., and H. S. de Brett, C.M.G.; Colonels P. H. Slee, C.M.G. and H. A. Bethell, C.M.G.

Among those present at the funeral was Lt.-Col. Pawson, R.H.A. (ret.) who, as a trumpeter, served under Sir Robert Biddulph in the Crimea, in 1/11 R.A.

After the interment the customary volleys were fired and Trumpeters of the Regiment sounded the "Last Post."

Numerous letters of sympathy and regret at inability to attend the funeral have been received by the family, all testifying to the great respect and affection in which the deceased General was held. Amongst others was a cablegram from General Sir F. R. Wingate, G.C.B., &c. from Cairo "Kindly give my deep sympathy to family on the passing of the Master Gunner."

Amongst a number of beautiful floral tributes were:—

1. A circular laurel wreath combined with clusters of choice flowers from the officers, R.A., Woolwich, "as a testimony of their respect and affection for their Master-Gunner."

2. An oval wreath of laurel with spray of palms, &c., tied with a wide riband of R A. Colours "From the members of the R.A. Institutioin with deep sympathy."

3. A pointed laurel wreath with red carnations, &c., tied with the R.A. Riband "In loving remembrance from the Children and Staff of the Royal Soldiers' Daughters' Home, Hampstead."

Thus was laid to rest, with the honour and respect befitting his high rank and distinguished career, one, who during a long and strenuous life devoted to the service of his Sovereign and Country, reflected credit and distinction on the Regiment in which he was brought up, and which now mourns his loss!

J.C.D.

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REMARKS ON THE VICE-PRESIDENT'S APPEAL TO THE MEMBERS R.A.I.

By Lieut.-Colonel H. W. L. Hime.

IT seems strange to complain of the want of contributions to the Journal in war time. It would have been past all explanation had the contributions not decreased in number when the mass of the Regiment was on active service.

It seems equally strange to complain that among the contributions none deals with the events of the war, seeing that an official ban was issued in the Journal against all allusion to them.

The Vice-President refers to the "abstruse problems" that have appeared of late years in the Journal. In some way I have missed them, although I read the Journal. Since the war, a number of short, practical and interesting papers have appeared on such subjects as "The Gunners Rule", "The Energy of a Cordite Charge", "High Angle Fire" &c., &c.; matters of which we might never have heard but for the war. Almost all such matters involve the use of mathematical symbols which seem to disquiet the Vice-President for some unaccountable reason. Let it be remembered that the guns with which we beat the Germans, and the airships by which we drove them from our shores, could not have been made without abstruse calculations in Mechanics and Hydrodynamics and the use of three condemned letters to which he objects. As to the "horrified layman" (para. 3), this personage seems a creature of the imagination. If he exists in the flesh, we need not trouble ourselves about him. The Journal was never intended for laymen, and we are not concerned with any opinion they may form on matters of which they know little or nothing.

In para. 3 the Vice-President gives a definition of the word 'education' which is wider in scope than any of the three definitions given by Stein, James Mill and Herbert Spencer to which Prof. Bain objects for being too wide. Speaking from memory, I do not think that the founders of the R.A.I., Eardley-Wilmott, Lefroy and Riddell, used the word education, but spoke of instruction—professional instruction; but if they did happen to have used the word education, we must treat them justly and use the word in the sense they used it, not in any new sense that may now be suggested. Their meaning of education undoubtedly was such knowledge as will enable a man to do his duty in that state of life in which he finds himself. In our

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particular case this means simply professional instruction; and this, and this only, is the object of the Journal. There is nothing singular or exceptional in its character. America and all European States possess precisely similar Journals,—and with far less reason than England, whose Artillery is scattered all over the world. The "human touch", to which the Vice-President refers, will not of course be found in any of these journals. They give only what they were intended to give—professional information.

The reasoning in paras. 4, 5 and 6 is so involved that I shall endeavour to put it in simpler form, premising that the Vice-President's apparent objects are to make the Journal *readable*, and to enable the officers who will be retired after the war to find employment.

When the Regiment expressed a wish for professional instruction in 1839, the R.A.I. was founded and ultimately produced a professional magazine which has always been more or less successful. Obviously, those seeking for some employment cannot reasonably expect to find the information they need in such a publication. If one wants a bulldog, one does not consult a clerical journal. To solve the difficulty, the Vice-President proposes to transform our professional Journal, which does not contain the needed information and which is unreadable from the presence of three obnoxious letters. He has known many a man, he tells us, who has "settled his career on the strength of a magazine article"; and he seems to believe that many of those about to retire could settle theirs by reading articles by our loyal fellow-subjects in distant lands, describing the incidents of their lives and their adventures by flood and field. The transformed Journal would apparently consist largely of such articles, the offensive letters being rigidly excluded.

The stress laid upon the word readable by the Vice-President reminds one of the deceptive old saying, "the proof of the pudding is the eating". So great is the diversity of tastes that what pleases one may not please another. Similarly what is thought readable by one man may not be thought so by another. There is a multitude of light magazines in England which may be read for diversion; why then meddle with our professional and very necessary Journal? We are all willing to help to the utmost the departing officers who fought their guns so nobly, and if a feasible plan be proposed for helping them it will receive ample support; but we strongly object to rob Peter in order to pay Paul. The proposed transformation of the Journal will probably encounter the firm opposition of a large body of members, and if unduly pressed may lead to undesirable consequences in an Institution mainly supported by voluntary subscriptions.

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ECHOES FROM THE MESS TABLE— AND ELSEWHERE.

BY "HENRY CLAY".

WHILE men's minds are turning eagerly, on the approach of Peace, to a consideration of the stupendous problems of re-organisation and repair which require solution before the convulsions of Europe die down, it is but natural that the thoughts of the Army should be pre-occupied with its future. Heaven forfend that I should plunge into the vortex by attempting an investigation of a subject of which no one outside the higher circles of the War Office can know the predominating factors. But the realisation of ignorance, when felt, never stops discussion in the Services and conjecture is always felt to be permissible. There are one or two points which are deserving of consideration, though they cannot of themselves alone lead one to any conclusions.

It is a commonplace that our Military Problem is more complex than, and of a different category to, that of any other nation. There are many factors which determined the size of the army before the war, from the number of recruits obtainable, to the maximum raiding force Germany was credited with being able to land on our shores.

But probably the predominant factor was the minimum force required for our foreign garrisons. The home Forces performed the rôle (*a*) of feeding the units abroad in peace, (*b*) of providing what was known first as the "Striking", and later as the "Expeditionary Force" in war. Infantry battalions at home and abroad balanced one another almost exactly. Field Artillery Batteries did not, there being roughly 50 abroad and 90 at home. Of these latter 72 were required for the 6 Divisions of the Expeditionary Force and the remainder as training centres in peace and depôts in war.

Now one of the first problems to be solved at the present time is the re-organisation, if any, of our foreign garrisons. New ones may be necessary, as in Mesopotamia; others may be reduced. If the latest paraphernalia of warfare is inapplicable to the N.W. Frontier, a Squadron of Aeroplanes and a Company of Tanks could overawe a native City of the Plains, and judiciously used lachrymatory gas would disperse a crowd. Thus a re-organisation of the components of some of our foreign garrisons may prove to be necessary. But any modifications due to the above causes seem likely to

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affect the infantry rather than the Artillery. For the Native Army, which has recently been largely increased, has no guns of its own, and its requirements will still have to be met by the British Artillery. The factors affecting the number of Batteries maintained in the Royal Regiment therefore will probably still lie in the size of the Expeditionary Force to be formed in War and the training of Special Reservists or Territorials or Universal-Training-Cadets to be carried out in Peace.

I am talking, of course, of the time when demobilisation has been completed. Till then, there will doubtless be a period when we will be taking our share in the Military occupation of Germany; and a larger force of Artillery will be required for that, than we are likely to retain afterwards. It is to be wondered what life in a Battery will be like during those days; what training will be carried out; and what facilities for training will be available. In all probability there will be, in the end, more fuss made over some paltry damage or trespassing in the land of the Boche, than there ever was in France or even England, for that matter.

* * * * * * * *

I believe that we shall find, when we have time to sit down and think about it, that our ideas have undergone as wide a development in this subject of training as in any other. It is to be hoped most devoutly that we shall never see again the parades dragged out from hour to hour merely for the sake of being on parade—a sight so common in pre-war days. In the first place there should be a great improvement in the type of Physical Training given. Few branches of the military curriculum have been developed further or on sounder lines than this of Physical Training; and for many a long day, no doubt, O'Grady's remarks or silences will be a feature of the Parade Ground—but not, I venture to suggest, the early morning Parade Ground. I know that this is a subject on which the prime-mover and mainspring of the "P. & B.T." in France feels very strongly. The inadvisability of such inhuman, pre-breakfast practices was borne in on him while training men for the Prize Ring, and his views are, I believe, now endorsed by the Medical Authorities. Were I a Junior Subaltern, faced with the duty of conducting such a Parade, I know how earnestly I should desire that these views might receive emphatic official endorsement.

Then musketry should be made more interesting than formerly by development on the lines of a certain demonstrator in France who is now well-known. Clear-cut and definite courses in map-reading have been laid down, which will be of service when struggling in future years with the education of the N.C.O. But the primary lesson we should have learned is the guiding principle of all training, emphasised so constantly by Maj.-Gen. Sir I. Maxse. "Explanation: Demonstration: Execution: Repetition." Let us hope that the sight of gun detachments, standing stonily rigid, while a young N.C.O. exercises his lungs and memory from a distance of 50 yards or more by pouring out paragraph after paragraph of the official language of the drill book, has passed for ever. It was in the act

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of passing when war broke out and there should be little fear of any backsliding. But it is being suggested that training methods in the Artillery have not made so much progress during the war as in other arms and branches of the military art, in which men with particular aptitude have been at work for some time past. The policy of encouraging initiative and avoiding cut and dried procedure has much to be said for it. But I am not sure that a universal policy, whether right or wrong, but preached and followed in all camps, is not preferable and would not be welcomed in the Regiment. It is a subject that deserves attention in the near future and I present the idea for an article in the Journal to any of our would-be Authors on "Modern Training Methods as applied to the Artillery."

The subject of teaching carries one's mind to the "Shop." There are rumours current of a proposal to transfer Woolwich to Sandhurst. At first hearing, it seems sacrilege. What an uprooting of traditions would the abandonment of the old buildings involve. There is more than mere sentiment concerned in the exchange of old buildings, encrusted with the memories of years, for newly glaring red-and-white quarters patterned on the latest R.M.C. buildings at Yorktown. If you don't think this is so, picture to yourself the feelings of a new arrival deposited by taxi, on the one hand, at the historic gates at Woolwich to pass along the front where thousands of predecessors have marched and wheeled and drilled before him: viewing for the first time the room, scarred by all kinds of by-gone skirmishes and escapades, which is to be his quarters until he rises to the heights of Corporal: the inner-court, to the walls of which the echoes of ancient roll-calls still seem to cling: the battery on the hill behind, where he hears the hoary yarn of the bread which was fired across the Common by rebellious cadets of other days. And then, on the other hand, (to go to the other end of the scale) figure to yourself the boy arriving, let us say, at a tented camp, similar to any other tented camp, except that a board at the entrance is inscribed, "Artillery and Engineer Cadet School." However old the Institution, qua Institution may be, there is nothing in such surroundings to bring the fact home to him. The freemasonry which is so strong amongst the old boys of ancient schools like Winchester and Eton is due largely, not to the abstract fact that their school has been an Institution for so many hundreds of years, but to the concrete existence of the picturesque old-world buildings amongst which they move through the impressionable years of their boyhood. The shadow of Old Windsor Castle has a greater influence on the souls of the thoughtless young savages who throng beneath it, than any of them are aware.

On the other hand, the exponents of co-operation between all arms, based on mutual esteem and knowledge, will doubtless welcome the suggestion gladly. The environments of pinewood and heath, they will point out, are more healthy than the bricks and mortar of slums; and the training facilities of Woolwich are not comparable to those of Berkshire. All of which is true and incontrovertible, and if the matter is taken up officially (for it is understood it has not reached that stage as yet) the sentimentalists will doubtless have to acquiesce

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with a sigh and comfort themselves with the reflection that it is all for the good of the Regiment. Progress is always effected, it seems, on the stepping-stones of cherished memories.

The Parade-ground in front of the R.M.A. may be more closely connected in some minds with evolutions, unwillingly performed at unearthly hours of the morning, than with other memories. To me it always recalls a scene of impudent bluff worthy of a better cause. The hero, whom we will call Jones (he left the service many years ago) had been a thorn in the side of the Authorities from the hour of his arrival as a "snooker". His latest exploit, although it bore every sign of his talented authorship, could not be brought home to him. The Commandant finally descended to stratagem in the hopes of inveigling Master Jones into confession. At a full strength parade, the Adjutant explained how proof of the authorship of the dastardly crime was in the hands of the Authorities. They had decided, however, in a magnanimous spirit, to give the Gentleman-Cadet concerned, this opportunity of owning up like a man instead of being arrested like a criminal. For a minute there was silence. Then Jones, leaving his place in the ranks, marched up and saluted smartly. Overjoyed with the apparent success of his ruse, the Adjutant burst forth into speech congratulating the delinquent on having taken his words to heart, and promising that frank confession would be taken into account in mitigation of punishment. Our hero listened respectfully to this harangue without a flicker and on its close saluted once more. "I beg your pardon' Sir," he said, "but I know nothing of the matter. There is a regulation that says that any money found on parade should be given to the Adjutant immediately and here is a penny I've just picked up," and pressing the coin into the hand of his mortified superior, he returned to the ranks.

* * * * * * * *

I have been turning over the pages of a book of pre-war newspaper-cuttings, dealing with military matters, which are interesting to read in the light of after events. To hark back to 1911, one of the leading military correspondents, commenting on the German manœuvres of that Autumn held in Mecklenburg, wrote: "These tactics may have their application in East Prussia, where the ground lends itself to special proceedings, and the Russian staff will surely take good note of the Kaiser-manöver of 1911. But on the French frontier, 150 miles in length, not more than six Army Corps could be deployed if they adopted the intervals of Mecklenburg and we come back once more to the dilemma that either these tactics have no application to a war against France, or else that the front of deployment of German Armies *will not be restricted by the frontiers of Neutral States*". As late as May, 1914, two articles appeared in the Morning Post entitled "Belgium and Luxembourg in a Franco-German War", in which the probability of the violation of her treaties by Germany was re-iterated in the light of the extensive strategical railway developments carried out towards the Belgian and Luxembourg frontiers since 1909. It is surprising that these articles did

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not make a greater impression in England than they did, so conclusive is the evidence of the strategical conceptions that the German Higher Command held. Their power to concentrate troops between Aix-la-Chapelle and Treves must have been quadrupled by the construction of the new lines, the doubling of old ones and the lavish provision of sidings and detraining stations in a deserted country of hill and moorland, lightly populated and of no commercial or industrial possibilities. The article concludes thus: "In view of the elaborate preparations for invading Belgium and Luxembourg should it prove militarily convenient, it may not be out of place in conclusion to recall that we are bound by treaty to protect both countries should their neutrality be violated. . . . In view of treaty obligations the German railway extensions towards Weiwertz, St. Vith, Pronsfeld and Treves are not without interest to the United Kingdom, quite apart from any question of an entente with France".

The United Kingdom had other things to think about at the time and eyes were turned towards Ireland rather than eastwards to the Belgian frontier. It is easy to be wise after the event, and the writing on the wall starts to the eye now. Reading it again brings home how blind the nation was then.

Curiously enough the last cutting in the book (for the July ones had not been pasted in) is a telegram, dated June 24th, 1914, reporting the opening by the Kaiser of the last enlarged lock on the Kiel Canal. It is believed that the completion of these locks was awaited before the steps which led to the outbreak of war were taken; and it is not without significance that the collection of cuttings, so full of portents of what was coming, should have terminated with the thinly-veiled news that Germany's preparations were completed.

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WHAT IS A NOMOGRAM?

By Lieut.-Col. R. K. Hezlet, d.s.o., R.A.

THE subject of Nomography has been dealt with before in the R.A. Journal by the writer of this note (see R.A.J., vol. 36, 1910, p. 457), but it has been suggested to him that the query which has been taken as a heading is often heard nowadays, and that it would be useful to provide a short general answer, in as plain and as untechnical terms as possible.

Adapting the French terminology of M. d'Ocagne, the great authority on the subject, the present writer in a pamphlet entitled "Nomography or the Graphic Representation of Formulæ" (published by the R.A. Institution in 1913) introduced the term "nomogram" in the following words:—

"Nomography may be shortly defined as that branch of Applied Mathematics which deals with the graphic representation of formulæ.

"This graphic representation takes the form of a permanent diagram the *Nomogram* which is available for use at any time, giving, when required, a solution of the formula by simply reading the diagram, without any additional construction being necessary."

He further divided Nomograms into "Intersection Diagrams" or "Alignment Diagrams" according as to whether the result was read from the *intersection of lines* or the *alignment of points*. This is in accordance with the nomenclature of M. d'Ocagne but it is the second type, the Alignment Diagram only, which is now generally referred to as a *Nomogram* and to which the term is practically confined.

A simple example will illustrate the distinction and the difference.

A calculation that is familiar to all gunners is the determination of the angle the direction of the wind makes with the Line of Fire as a preliminary to the application of wind corrections.

The true bearing of the Line of Fire is known and "Meteor" gives the direction from which the "equivalent constant" or "ballistic" wind is blowing, also in the form of a true bearing. A subtraction sum then gives the angle the wind direction makes with the Line of Fire. This may be done in the head, with the aid of a rough sketch on a piece of paper, or by the help of one of the numerous "gadgets" with revolving discs and arms which have been devised for the purpose.

An "Intersection Diagram" or an "Alignment Diagram" can also be constructed for the purpose and will serve to illustrate the meaning of these terms.

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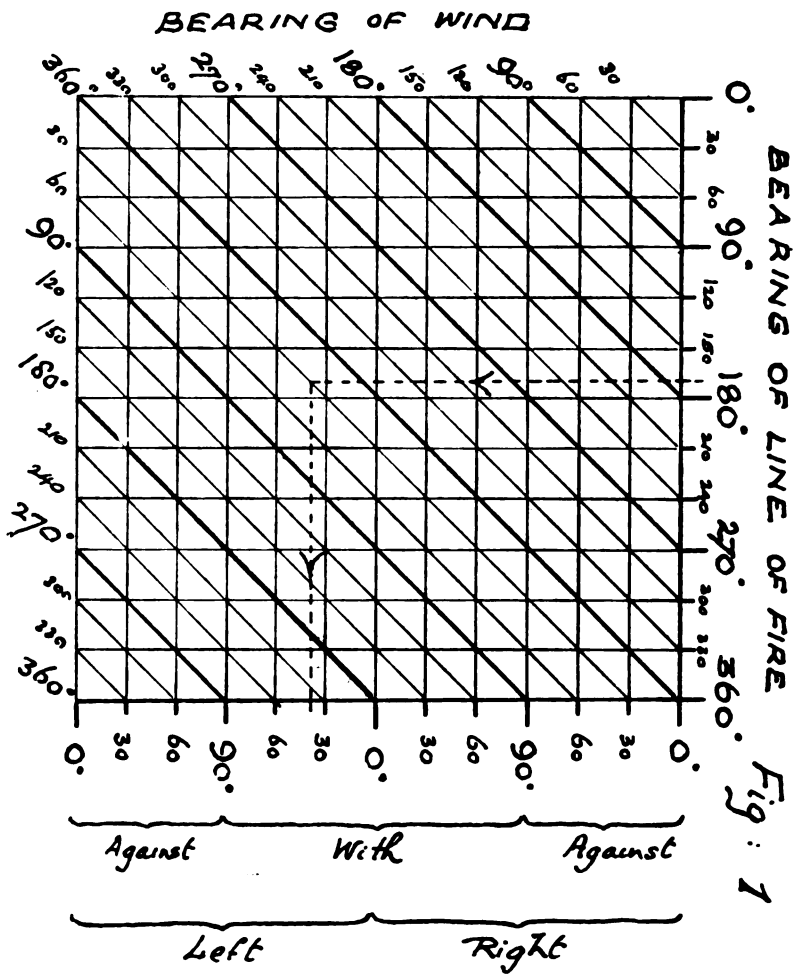

Fig. 1

Ex: Bearing of L. of F. = 170°, Bearing of Wind = 30°
Angle Wind makes with L. of F. = 40° With and Left
(See dotted lines and arrows).

The calculation is no doubt a very simple one but it is just for this reason that it has been selected as an example, as there is no complicated formula to explain, and the construction of the diagram is easy to follow.

It may also be remarked that mistakes *have* been known to be made in this calculation, and the nomogram is as nearly "fool proof" as is possible. Fig. 1 shews the Intersection Diagram; Fig. 2 shews the Alignment Diagram and as explained above it is Fig. 2 which is now generally known as a *Nomogram*.

In Fig. 1 the answer is read by the intersection of three straight lines. We follow a vertical line through the given value of the Bearing of the Line of Fire until it cuts the sloping line marked with the given value of the Bearing of the Wind. From this point

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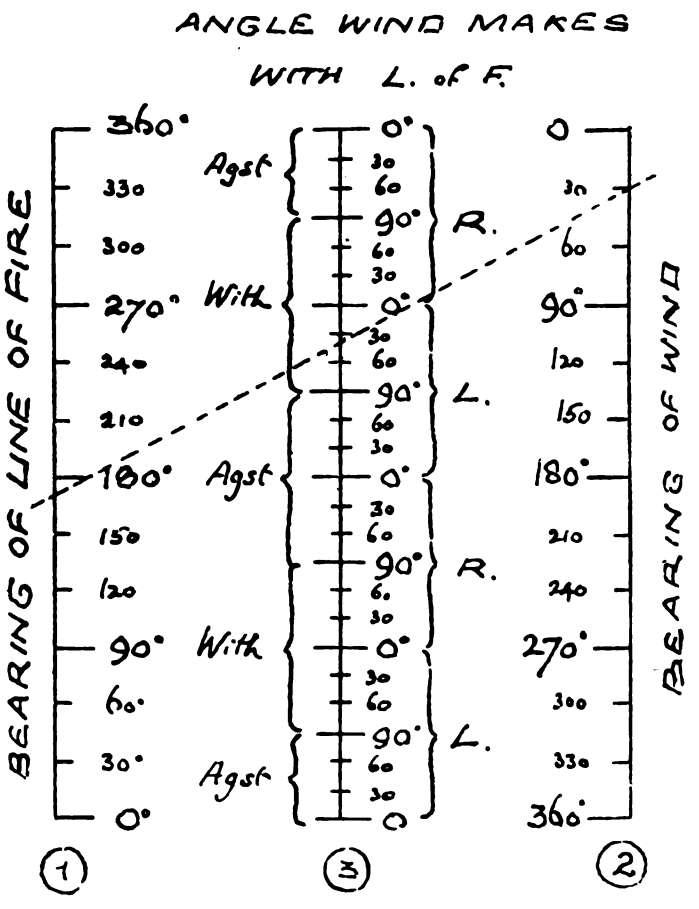
we follow a horizontal line till it cuts the right hand scale at the corresponding Angle which the Wind makes with the Line of Fire. A numerical example is given and marked on Fig. 1.

In Fig. 2 however the answer is read by the alignment of three points on a straight line. We join the given value of the Bearing of the Line of Fire on the left hand scale to the given value of the Bearing of the Wind at the right hand scale and read the answer where this straight line cuts the centre scale.

Fig: 2



Straight Line joining Bearing of L. of F. on scale (1) to Bearing of Wind direction on scale (2) cuts scale (3) at the Angle which the Wind makes with the L. of F.

Ex: Bearing of L. of F. = 170° Bearing of Wind = 30°
Angle Wind makes with L. of F. = 40° With and Left.
(See dotted line).

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The same numerical example as in Fig. 1 is given and marked on Fig. 2.

A comparison of the two diagrams leads to the conclusion that the *Nomogram*, Fig. 2, is easier to read than Fig. 1. The tracing out of the particular lines required in the somewhat complicated network of Fig. 1 is distinctly troublesome, especially for certain eyesights. On the other hand in the nomogram we have only the reading of three simple scales to contend with, the diagram is much less complicated and clearer to read.

This is the advantage of the Nomogram over the Intersection Diagram.

In conclusion it may be well to state that the actual construction of the usual simple types of nomogram is not at all difficult, and it is not necessary to delve at all deeply into the underlying theory in order to be able to construct them.

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TACTICAL EXERCISES WITHOUT TROOPS.

By Major-Genl. H. C. C. Uniacke, C.B., C.M.G.

A. THEIR OBJECT.

1. *To give officers and N.C.O's. confidence in handling situations that occur in the field and thereby to increase initiative.*

(a) Practice begets confidence and confidence generates initiative.

(b) The period available for training is usually so short and the amount of work to be got through so great that Brigade and Battery Commanders have, comparatively speaking, few opportunities of actually handling their commands in dealing with tactical situations. Moreover on these occasions Battery and Section Commanders have to devote so much attention to "individual training" in their units that they cannot possibly give undivided attention to the solving of tactical problems.

(c) Tactical problems should, therefore, be worked out by the commanders without troops, so that when troops *are* present, they can give the greater portion of their attention to the work of their men.

(d) The ways in which a *man* should act on receiving any given order are extremely limited and can be taught in a very restricted area.

But the ways in which a commander may decide to employ his men in order to meet different tactical situations, are of the most varied description. It is, therefore, far easier to train men to carry out the orders of a commander than it is to train commanders to decide on the orders they will give those men. This difference between the training required by commanders and men should be grasped. (The moment a man becomes a bombardier he becomes a "commander".)

(e) Constant practice by means of tactical exercises is the only way in which commanders can be given sufficient practice in solving those tactical problems which arise in the field, and in meeting the unexpected which always happens in war.

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2. *To co-ordinate the ideas of all commanders.*

(a) Brigade and Battery Commanders must realise the necessity for their commands being trained exactly on the same lines. They all belong to one Regiment and must hold one doctrine and one only.

(b) Situations will constantly arise in the course of operations when commanders, especially Divisional Artillery Commanders, will find it impossible to communicate with their subordinates. If similar situations have been dealt with in the course of Tactical Exercises, each subordinate will then know the general lines on which he should act, *even if no orders reach him.*

(c) The man who imagines that he will be capable of solving a problem correctly under the stress of battle, when he is unable to do so in peace surroundings, is a fool. In any case, without constant practice he will often find himself incapable of conveying his solution to his subordinates plainly and intelligibly.

3. *To give practice in issuing clear, concise verbal orders, and in writing clear, concise messages.*

4. *To avoid false situations.*

What officers and men are taught to do on the training ground they will certainly do during operations. When troops are actually present on the ground, false situations usually arise owing to crops, boundaries, &c. The baneful influence of this can be corrected by means of tactical exercises. A few mounted officers and men can always go, without damage, where batteries could not. False situations are thereby avoided.

5. *To train officers in coming to a clear, definite and rapid decision after "appreciating" any given situation.*

In war, opportunities will not wait, TIME is an all important factor, and intelligent FORESIGHT is beyond all price.

B. THEIR CONDUCT.

6. In order to obtain any value from a Tactical Exercise it is essential that the Instructor should be on the best of terms with his class. The latter, on their part, must realise that the Instructor is out to help, and not to find fault. No matter how stupid an answer may be given or question asked, the Instructor must never be sarcastic or funny at an officer's or even more especially, a N.C.O's expense. Such a mode of action will simply tend to dry up all discussion and 75% of the value of the exercise will be lost. The Instructor must encourage discussion and questions by every means in his power. He must remember that there are two or three ways of carrying out any given military operation all of which may be right—that there are certain ways of carrying out any military operation which are invariably wrong. He should therefore point out what, under *all* circumstances is wrong, viz:—the violation of an established principle. By this means the officers and N.C.O's carrying out the scheme will require a valuable guide as to what is *right.*

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He must be careful to point out the good points and the weak points of each solution given and must finish up by pointing out what he considers as probably, but not necessarily, the best solution *as well as the lessons to be learnt from the problem.*

7. Problems set at a Battery or Section Exercise must be of the simplest character and must be gone into in the greatest detail.

8. A Tactical Exercise may be carried out in anything from thirty seconds to two hours. It should seldom last more than two hours and one hour is usually ample. Whatever happens the learner must not be allowed to get *bored*. Once the learner is bored, the trainer is defeated. *Without life and interest all work is valueless.*

9. A large number of officers in the Regiment are terrified of trying to arrange a Tactical Exercise. They seem to imagine that long-winded General and Special Ideas are essential and that it is necessary to spend a considerable time looking for a very special piece of ground.

It must be realised that fighting takes place over *every* sort of ground, and it is over *every* sort of ground that Tactical Exercises should be held. Unless it is desired to bring out some very special lesson it is rarely necessary to go more than quite a short distance from billets or camp. One General Idea will last for months and Special Ideas can be given verbally on the ground.

10. Officers and N.C.O's must be given every kind of impromptu situation to solve when on the march, during halts and at any other available time. Officers must be encouraged when out walking or riding to set each other simple problems. By these means the fear of arranging Tactical Exercises will be removed.

11. "Syndicates" are a mistake. The chief value of "Tactical Exercises" is to make people *think*. When syndicates are formed, one member, as a rule the gas-bag of the party, usually thinks and talks or else talks and does *not* think, and the remainder listen.

12. Three or four people at a time need only be asked for their solutions, and the instructor can then sum up. As long as it is realised that *anyone* in the party may be called on for his solution the *whole* will think out the problem.

13. Orders must be given either verbally or in writing. Never let people say *what they would do*. MAKE THEM GIVE ACTUAL ORDERS, exactly as though their men were present.

14. When a situation is given the officer, or N.C.O., from whom the solution is required, should be at the actual spot and in the actual position that he would normally be if his battery, section, etc. were present on the ground.

15. Before giving any tactical orders a Commander should always give HIS INTENTION. This is often omitted at Tactical Exercises but it is essential that it should become second nature with *every* officer to give this information before giving his orders. A subordinate, even if he finds that from any cause, enemy action or otherwise, he cannot comply with the actual *orders* given to him, can then still act so as to carry out his commander's *INTENTION.*

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The task of the subordinate as regards his course of action, is thus considerably eased with respect to the application of the principles laid down in Section 12, para. 13, F.S.R. Part 1—principles, especially that in sub. para. iii, which should be engrained in the mind of every artillery officer.

16. Clearness of orders must occasionally be tested by having the same orders given to two or three different people—each should then be asked in turn what these orders conveyed to him. It will often be found that they convey something quite different to each recipient, and to *none* just what the commander intended.

17. When a problem has to be solved it is necessary to consider the exact position of leaders and troops at the moment the commander would issue his orders. It is quite common, at Tactical Exercises, to find commanders issuing *verbal* orders direct to individuals, etc., who, under normal fighting conditions, would never be there to receive them. *Tactical Exercises must be practical.*

18. Every opportunity must be taken by Instructors to lay stress at all times on the fact that the broad principles laid down in our training manuals are as true to-day as they were before the war. Practically every reverse that has been suffered by us during operations whether in trench or semi-open warfare, can be directly traced to the non-observance of one or more of these principles. Adherence to them has invariably spelt success, and it is the duty of every officer to study them closely.

19. Whatever form the exercise may take, the very smallest details must be entered into. There is no limited liability in modern war. Success in battle is largely dependent on the care and forethought exercised by Commanders in laying down their initial plans, not only as regards the general scheme for the attack but most particularly as regards the smaller details. In war it is the little things that count, and much of what is called bad luck can be attributed to nothing else but a lack of careful foresight in this respect. Most battles have been won or lost before zero hour.

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THE GERMAN INVASION OF ENGLAND.

Xth to XVIth Centuries.

By Brig.-General F. G. Stone, c.m.g.

THE German Invasion of England which began in the Xth Century and terminated in the reign of Queen Elizabeth, was in no sense a military invasion; it was purely economic and typical of 'peaceful penetration' carried out and brought to great perfection by a judicious admixture of bribery and force with a highly organised and intelligent trading system.

Those who have imagined that the modern German Power was purely militarist, and identified with the Hohenzollern régime, and would therefore cease to be a menace with the establishment of an absolutely democratic form of government,—have studied only the rise of the modern German Empire under the hegemony of Prussia—'Prussia,' which was defined by Bismarck as 'an Army with a country'; the Prussia which was the creation of Frederick William I and Frederick the Great. Or, if they have studied the early history of Germany, the Germany of Charlemagne and Frederick Barbarossa and of the Holy Roman Empire, they have again been absorbed in the military achievments of the Feudal period in which Germany played the leading rôle; without taking cognizance of the fact, that the instinctive cupidity and ambition of the ruling classes of Germany which prompted the dominant idea of *Deutschland uber alles* and was suitably recognized by Pope Leo III when he conferred the title of "Holy Roman Emperor' upon Charlemagne,—were also shared by the despised 'Third Estate', which, under the feudal system, was scarcely recognized, except in so far as it was useful to provide 'cannon fodder' and munitions of war for military enterprises, and cash to finance the same.

To understand the extraordinary domination of Germany over the finances and trade of England from the Xth to the XVIth centuries, it is necessary to study the history of the Hansa Cities and the Hanseatic League: in doing so, we shall find that this purely democratic association, in the days before the dissolution of the Holy Roman Empire—i.e. the first German Empire—,obtained their hold over this country and influenced its rulers, by very much the same methods as, in these latter days, have been practised with such marked success by the agents and statesmen of the second German Empire, under the guidance of the great general Staff and the active encouragement of the Kaiser.

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The same forces are still at work, and will continue to work, notwithstanding the acknowledged defeat of Germany in arms; they will find the League of Nations easier to deal with, than their ancestors found Queen Elizabeth.

The outstanding feature of German economic penetration in the early days of English history is that it was organised, directed, and controlled by the German people, and not by their rulers: the 'militarism' of the feudal period was being directed by the rulers of Germany on lines which were entirely unconnected with the commercial enterprise of the citizens; in fact there was no idea of co-ordination between the two, so far as the 'ruling class' was concerned: the commercial class, as represented in the Hanseatic League, as it became more and more powerful, evolved a definite military policy, for the furtherance of its own aims, but it made use of the military ambitions of other people to promote its ends.

We shall do well to remember this, and avoid falling into the error, that the downfall of the Monarchy in Germany, will in any way affect the danger of the economic conquest of the British Empire by the German people. The actual date when German merchants first established themselves in England, is somewhat uncertain, but it was probably during the reign of Charlemagne (768 to 814). The first record of the preferential treatment which was accorded to them right up to the reign of Queen Elizabeth, occurs in a document of the time of Ethelred the Unready (978—1016) in which the following particulars are given:—"Subjects of the Emperor (i.e. German merchants from the Holy Roman Empire) who arrive in their ships" are to be considered on an equality with Londoners in respect to the laws, and they are granted preferential treatment over other foreigners; they were also to be allowed to purchase wool and tallow (the most important of English exports), on *board their own ships*, "whereby probably the payment of certain market duties was avoided." This was in direct contravention of the old English law which forbade foreigners to live in the City except as paying guests of the citizens, who received a commission on their sales. This custom was called 'hosting' and the Londoners fought stoutly for it in defence of their rights, all through the Middle Ages. The position and influence of the Germans in England was improved further by the marriage of King Canute's daughter to the son of Conrad II, who afterwards became Emperor Henry III. Freeman, who is always 'pro-German', writes that in the time of Edward the Confessor "The German connection was cultivated by the patriotic party as a counterpoise to the French tendencies of the King."[1]

We can readily imagine the kind of influence which caused the 'patriotic' party to cultivate this connection! Harold seems to have completely Germanised the Church of England in respect to the high appointments in the Church.

William the Conqueror still further exalted the horn of the Germans in England by his marriage with Matilda, daughter of the Count of Flanders: the connection does not seem obvious at first sight, but when it is realised that the prosperity of the Flemish cities

[1] "Norman Conquest"; Vol. II, page 57.

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and harbours was bound up in their commerce and traffic with the Rhineland and Cologne, we begin to see how much this marriage was able to influence the destinies of the German merchants in England. Flanders was willing enough to help William in the conquest of England for her own benefit, inasmuch, as England was the wool farm of the Flemish weavers.

Freeman writing of this period quotes William of Poictiers:—"Strangers of Teutonic birth had settled in the land to practise the gainful craft of goldsmith and moneyer (money lender or banker).

It is however in the reign of the Emperor Frederick I (Barbarossa) (1123—1190) that we come upon documentary evidence of the greatest value in regard to the establishment of the German merchants in England. In a letter written by Thomas à Beckett, Henry II's great Chancellor, (1157) to Frederick Barbarossa, the following passage occurs:—"Sint inter nos et populos nostros, dilectiones et pacis mintas indivisa, commercia tuta." This letter shows that Cologne already had a Guildhall in London, and that there must have been an earlier charter (of which there is no record) of which the letter in question is confirmatory and enlarging in character. "The people of Cologne were definitely put on a level with the King's subjects: they were given the right to hold property in London and were not to be affected by new customs. By this last provision they were placed in a more favourable position than the English themselves. In course of time, as customs rose, the Germans continued to pay the old rates; German trade was thus given a preference, not merely over other foreign trade, but over goods imported by the King's own subjects".[1]

Of course there was a price paid for these concessions, and there is no doubt that the German bankers financed Henry's wars in Wales and France—not without exacting a sufficient rate of interest on their loans.

We must now consider the rise of the Hanseatic League under whose domination England struggled in vain, throughout the Middle Ages; until that great Queen Elizabeth set her free from the German incubus up to the time that 'peaceful penetration' once more began its deadly work in Queen Victoria's reign. The League of the Hansa Cities was a secret society of Merchants, banded together by rules of the most stringent character. The principal reason for secrecy, and incidentally, the explanation of the absence of records as to its foundation and membership in early days, is that it was an illegal combination which could not be officially recognized under the statutes of the Holy Roman Empire, of which the Pope was the spiritual head, and German Kings were the temporal Emperors. The story of the rise of the Hansa League is at the same time the story of the ultimate downfall of German world dominion in the Middle Ages.

In the reign of Frederick Barbarossa, we find for the first time mentioned as a power in the state, a few of the many German cities which had arisen under the fostering care of Henry the Fowler. Frederick Barbarossa encouraged the development of the 'third estate' for a double purpose; the growth of industry and commerce

[1] "The Germans in England"; by Ian Colvin.

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produced wealth which could be taxed for the maintenance of his armies, and it also at the same time created a powerful class which could be played off against the recalcitrant nobility of his allies when it suited him. He was ever ready, in return for loyal aid, to grant valuable concessions which were ultimately to bring about the evolution of a considerable number of powerful 'free cities'. Thus the growth of freedom in his own country, was actually one of the strongest contributing factors to its destruction beyond the Alps, by the armed forces of the Holy Roman Empire with the German Barbarossa as supreme War Lord. But as time went on, the unnatural union of the Roman Empire with the German Monarchy, began to prove fatal to the former and ruinous to the latter. The 'Emperor' was not a hereditary ruler, but was appointed by the 'Electors' who were all territorial princes much more interested in securing the maximum of independence for themselves, than in the success of the Empire in the difficult task of ruling the world: it was indeed to their own interests to appoint a weak, rather than a strong Emperor. The inevitable climax was hastened by the open revolt of the League of Lombard Cities which ended in the ignominious expulsion of the German Kings from Italy. Returning to their own dominions, they found that their prestige had diminished during their long absences, and that under free municipal institutions, their subjects had learnt to look to themselves rather than to their feudal lords, for their welfare in the struggle for existence. Concurrently with their own diminishing power, they found themselves faced with the steady increasing power of just such a League of Cities at home, as had already destroyed their power abroad.

"To be sovereigns of the world, the German Emperors had staked their national existence, and lost."[1]

Curious how history repeats itself!

In the year 1241, at a time when both the Papal and Imperial thrones were vacant, we first hear of the League of the Hansa Cities, or 'Hanseatic League', under the leadership of the free city of Lübeck. The proud position of Lübeck as head of the powerful League of Hansa Cities was officially confirmed, more than a century later by the gorgeous ceremonial visit of the Emperor Charles IV in 1376. The number of cities which were members of the League about this time, has been variously computed from seventy to ninety-six; the main strength of the League was in the Baltic towns of Lübeck, Wismar, Rostock, Stralsund, Greifswald, Stettin, Demmin, and Auklam, closely allied with certain cities of Prussia and Pomerania—Bremen, Hamburg, Dantzig, Elbing, and Königsberg.

We have already seen that the merchants of Cologne had by a system of judicious bribery established themselves firmly in London, with preferential rights to the detriment of British merchants, firmly secured to them by King John in 1213; and this was followed up by Richard in 1260, who confirmed the rights of the German federation in the possession of their Guildhall and assured them of "royal protection for all those liberties and customs which they enjoyed in

[1] "The Hansa Towns"; by H. Zimmern.

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his time and the times of his ancestors." Thus it was not only Cologne, but "the merchants of the Alemannic (German) Empire," who had got their feet firmly planted in British soil, to the detriment of our own people.

The German Guildhall in London was subsequently known as the 'Steelyard'. It was situated in Thames Street on the left bank of the river, close to Dowgate, just above London Bridge, which in early times was the only city gate that commanded the water. The whole length of this street leading to the water gate, was lined with wharves, warehouses, and dwelling houses of the Germans. By their position, they held the key to the whole water-borne commerce of London.

The privileges of the Hanseatic merchants were extended by Edward I in return for cash consideration. Edward III pawned his crown and jewels for a large sum of money, the pledges being safely housed at Cologne; they were ultimately redeemed for him by the merchants of the Steelyard, who handed over a sum of £30,000 to help him in his war with France. Among the valuable considerations which helped Edward to secure this sum of money, were the lease of the tin mines belonging to the Black Prince in the Duchy of Cornwall, and of a number of farms situated in different parts of England, for the space of a thousand years. But there was another purpose behind these transactions, beyond the economic subjection of England; this purpose was the undisguised determination to crush France as a military power, and the Hanseatic League was making use of the military ambition of English kings, to effect its purpose.

Then, as now, the people of England regarded this foreign economic invasion with deep distrust. "Full of a just sentiment of what they could do by themselves, and of what they were hindered from doing by these foreign monopolists, they bore their presence with extreme impatience. Feuds and riots were not infrequent, and no royal favours, no Hanseatic ships of war could save them from occasional brutal attacks by the mob. Thus during the Wat Tyler rebellion, the people pursued the hated foreigners even into the sanctuary of the church, murdering mercilessly all those who could not pronounce the words "bread and cheese" with the pure English accent. But these rebellions were quelled by the royal commands, or extinguished themselves by the fact that the Hanseatics were also useful to the English people, oppressed by the feudal system and engaged in constant wars, whose trade industries were thus unable to develop quickly. Nor did such passing storms shake the power or the resistance of the Hanseatics. Bloody encounters, rude tumults, were entirely in keeping with the license and roughness of the times, and were met with by the League in all its foreign stations."[1]

The growing resentment against the Germans began also to find vent in frequent acts of piracy against Hansa ships, which led to the fiercest reprisals. In Henry IV's reign, the Danes joined forces with the Hanseatics and harassed the English on sea and land: the English replied by seizing the Hansa depôt in London, and killing or imprisoning the occupants: the League retaliated by closing the

[1] The Hansa Towns by H. Zimmern.

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Baltic to British ships, and seized every vessel upon which it could lay hands. The Hanseatics even landed in England itself, and pitilessly ravaged many of the maritime provinces, hanging to the yards of their ships all the prisoners whom they captured.

Ruthlessness is not a modern invention of Kaiserism. Finally, this disastrous conflict was brought to an end by Charles the Bold, Duke of Burgundy, to whom the King of England had appealed. A congress was assembled at Utrecht to arbitrate between the contending parties; the result of which was the Treaty of Utrecht, which was subsequently ratified by Edward IV: this treaty gave English merchants liberty to trade in the Baltic, and with the Hanseatic ports of Dantzig and Russia, but it also reconfirmed all the ancient monopolies and privileges of the League, and further accorded to the Germans in England new and important favours. The consolidation of the League's position at this epoch of our history was most certainly brought about by sea power, in which the League excelled. The feeble and stormy period of Henry VI, the wars of the Roses, the long and constant hostilities with France, and the defection of the Duke of Burgundy, all favoured the League, which knew well how to take full advantage of England's weakness in order to consolidate and strengthen its own position in the country where it had established itself like a deadly parasite.

"In no place, not even in Bergen, did the Hanseatics succeed in enjoying greater independence. Their factory was privileged, and while benefiting by English law, they were quite independent of it. Everything therefore was favourable to their commerce, and they were hampered by no such restrictions as weighed not only on other foreigners, but upon the English themselves".[1]

The comment of the author of 'The Hansa Towns' upon the condition of affairs in England at this period is most significant and may be studied with advantage by those who advocate the resumption of pre-war economic relations with Germany at the conclusion of peace.

"Such was the effect of the fear which the League inspired in the English; such too was the ignorance of their government, which being in possession of a power not less great, and had they desired, even greater than that of their rivals, allowed strangers to deprive them of the most useful of all independent rights, that of utilising for their own profit, the resource of their own labour and their own soil." H. Zimmern characterises the failure of the government to safeguard English industry and commerce, as 'ignorance': such 'ignorance' can be fostered by such means as the League knew how to employ them, and which the Germans of to-day understand from A to Z.

The treaty of Utrecht survived until the reign of Edward VI and was the foundation upon which all other treaties between the English and the Hanseatics were based.

Henry VII left the Hansa privileges intact; and Henry VIII, influenced by powerful political motives, even extended them.

[1] The Hansa Towns by H. Zimmern.

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Edward VI who was only ten years of age when he succeeded his father, confirmed all the Hanseatic privileges on his accession: but his reign was destined to give the first real shock to the League, which it had sustained since it first began to undermine the foundations of British commercial prosperity. So great had become the influence of the League at this time, that its name had to be associated with those of the great contracting parties in all commercial treaties between England and France. But the apparent security of the League was about to be rudely shaken.

The Merchant Adventurers Company had been formed in early days to organise a foreign market for English cloth, in the hands of English agents; and from the very outset was in conflict with the Hanseatic League, from which it seems to have largely borrowed its organisation.[1] Sir Thomas Gresham indeed alludes to it as the "New Hansa."

In April 1551 the accumulated grievances of the English Merchants and of English industries, came to a head in an elaborate plot to oust the hated foreigners from their position: this plot being discovered, the King ordered an enquiry. Sir Thomas Gresham, the founder of the Royal Exchange, took up the case for the Merchant Adventurers; he had already made it clear to the young King and to his guardian, the Duke of Northumberland, that the continued existence of the 'Steelyard' was incompatible with the freedom and prosperity of England, the fiscal privileges accorded to the League being a dead weight on English commerce and a determining factor in producing and maintaining an adverse rate of exchange. The King was moreover by no means inclined, as a protestant sovereign, to regard with favour the powerful syndicate of foreigners, who owned allegiance to the Emperor, a potentate for whom he entertained the most profound distrust and hatred, as the persecutor of his co-religionists of the protestant faith.

For the first time then, the grievances of the English against foreigners in their midst, found a sympathetic hearing: the representative members of the Steelyard were cited before the Privy Council, which, after a very brief consideration of the evidence, decided (Feb. 23rd 1552) "that the Hansa, an illegal body, the names and origin of whose members were unknown, had, by the importation and adulteration of foreign goods, forfeited the privileges accorded to them by Edward VI."

The League was immediately placed on the same footing as all other foreigners, i.e. without any special privileges which would place them at an advantage as against the English.

But the Hanseatic Diet promptly sent an ambassader to treat with Edward and his Council, with the result that in July of the same year, the Hansa privileges were provisionally restored "as far as was reconcilable with the justice, fairness, and honour of the king." Though, for the moment, the Hanseatics appeared to have won the day, they had received a warning by which they were not slow to profit, and in 1553 the Steelyard submitted for the King's

[1] "Treatise of Commerce"—Wheeler.

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approval a revised code of rules and regulations, admirably adapted to throw dust in the eyes of the unwary, but in reality not giving up one iota of the cherished privileges which they had wrung from successive Kings and Ministers of England.

But King Edward VI, who seems to have been more sceptical of German altruism than Mr. Asquith's cabinet, showed little inclination to give serious consideration to these statutes, or to revoke permanently his original decision, and there is little doubt that had he lived, the Hansa power in England would have been completely crippled in his reign, and English industry and commerce would have come into its own.

But the time was not yet; and the reaction caused by the accession of his sister 'Bloody Mary,' to the throne, on his death, established the complete triumph of the League:—then, as now, the German bankers and merchants understood the art of corruption. The annulment of Edward VI's statute was carried through by the Queen and her corrupt ministers, in face of the most formidable opposition in Parliament, and the protests of the Lord Mayor and citizens of London.

But the aggrieved citizens of London did not allow matters to rest where they stood[1] and after the lapse of a few months, the leading members of the Steelyard were cited to appear before the Queen's Privy Council to answer to a long catalogue of charges against them. Without enumerating these charges, it is of more than passing interest to note, that one of the chief indictments against them was, that the Hansa permitted no reciprocity in trade, and that while they enjoyed special customs privileges in England, they levied heavy duties against English imports carried in English ships at all their overseas ports.[2].

The Privy Council decided on a considerable curtailment of the Hansa privileges, and wound up by threatening an entire suppression of all their privileges, if there was any attempt to evade the orders of the Council. The next few years saw the most intense activity on the part of the League to obtain a mitigation of this ruling: embassies, intrigues, and every form of bribery and corruption were tried in vain, and finally the Hanseatic Diet played its last card by threatening to break off relations with England. This would have proved a two edged sword, had it been really effective, for it would

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[1] A memorandum drawn up by Syndic Sudermann gives a vivid picture of what is implied by the Hanseatic privileges. and how grievously our people suffered in consequence thereof. One instance is sufficiently significant: From January to November, 1554, the League exported 36,000 pieces of cloth, as against 1,100 exported by English merchants; on these they paid export duty of threepence for each piece, while other foreigners paid five shillings and ninepence.

[2] An American friend of the author's was travelling in Germany some ten years ago; he was lunching one day with the Chancellor of the Duchy of Baden, and complained of the extortionate customs dues which he had been called upon to pay that very morning on an English suit of clothes: the Chancellor suggested that he could get very good clothes in Germany; but the American said he preferred London, and added—"If the suit had come from America I should not grumble, as we reciprocate your tariffs every time; but I often wonder how long John Bull will continue to put up with such a one-sided arrangement." The Chancellor replied—"The day that England taxes German imports, we shall declare war; we cannot exist without our free import trade with England."

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certainly have terminated the career of the Hansa in England: but the power of the League had dwindled, and many foreign ports were no longer blindly obedient to the orders of its ruling body.

This was the state of affairs (1558) when Mary died and was succeeded by Elizabeth, who more than any sovereign or minister, before or since, governed on the principle of 'England for the English.' The Queen gave a gracious reception to the Hanseatic embassy which waited on her in May 1560, but she made no concessions.

The Merchant Adventurers encouraged by Gresham, made their petition to Elizabeth for the curtailment of Hansa privileges: advised by that wise statesman Lord Burleigh, the Queen listened carefully and sympathetically to the petitioners, and took immediate steps in the desired direction. This was followed up by an active correspondence between the Queen and the Hansa cities in which she emphatically declared that they must renounce their antiquated pretensions, but that, on the other hand, she was willing to give them the benefit of the 'most favoured nation' clause against other foreigners, but insisted that her own subjects should receive the benefit of reciprocal treatment in the Hansa towns.

The authorities of the Steelyard, influenced by a lively apprehension that worse things might be in store for them if the perfectly reasonable terms of Elizabeth were rejected, strongly advised acceptance; but the Hansa Diet, quite blind to the signs of the times, endeavoured to obtain the intervention of the Emperor. A letter from the Emperor was presented to Elizabeth by the Aldermen of the Steelyard, and there was some plain speaking by Burleigh: Elizabeth remained firm, and no concessions were made.

Year by year, under the enlightened policy of the great Queen, which before all things held the ideal of "England for the English" in view, the prosperity and power of the English Merchant Adventurers increased, and the cohesion and influence of the great Hanseatic League diminished. The Hansa in London had begun to realise that it were best for them to abide loyally by their agreements with the English Queen, and ignore or evade the orders which they received from the Hansa Diet at Lübeck; Hamburg too, seeing the prosperity of the port of Embden, through which all the continental commerce of England had passed since the Hansa Diet had decreed a boycott against England—became uneasy on her own account, and started to establish direct relations with London, in spite of the violent protests of Lübeck. In fact, the attitude of Hamburg was distinctly progressive and in favour of the commercial reciprocity which had been agreed to at the Treaty of Utrecht: while Lübeck, reactionary to the last degree, and living in an atmosphere of the past stubbornly refused to concede one jot of the claims of the League to world supremacy in the commercial and industrial field, and utterly declined to listen to the arguments of Hamburg in regard to the obligation which rested upon all the Hansa towns, to honour the statutes of the Treaty in respect to reciprocity towards England.

It must not however be supposed that the attitude of Hamburg was in any way due to an honourable sense of moral obligation; it

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was solely due to the success of the English Merchants under their enlightened and determined Sovereign, in countering the Hanseatic boycott and establishing a prosperous continental depôt—outside the League—at Embden, which bade fair to rival and outstrip Hamburg, unless the latter chose to haul down its flag. The vigorous policy of Elizabeth was beginning to bring about the disintegration of the Hanseatic world dominion, by internal dissensions, which became more and more active, in proportion to the accumulating evidence that it would pay to make the best terms possible with the winning side—and there could be no doubt that Elizabeth meant winning.

But the end was not yet. A visit to Hamburg by Dr. Westendorpe of Gröningen brought about a reaction in favour of loyalty to the League against England, when the burghers heard "of the great preparation in hand and the invasion intended by the King of Spain against England, of which the Hamburgers (it would seem) conceived no small hope." The result was that the negociations which had been opened between the Merchant Adventurers and Hamburg, proved abortive.

The immediate result was that the English Merchants opened a depôt at Stade, which in a very short time was transformed into a flourishing trade centre—unhampered by the dominion of the League.

Meanwhile Elizabeth's intelligent and virile commercial policy, had been opening up new trade routes on the continent, uncontrolled by the League, and indeed in active competition with the old channels which had for so long sufficed to maintain intact the supremacy of the League.

We must now take a glance at the relations which existed between the Hanseatic League and other Powers interested in the Baltic trade.

From 1511 there had been open enmity and occasional fighting between the League and the Dutch Towns which, like Embden and Stade, had never been deemed worthy of incorporation. The Dutch had received help from the Danes. In 1553 Christian III raised the tolls of the Sound to a point which crippled the Hansa depôt at Bergen. A few years later, the Russians drove the German merchants out of Novgorod, the Hansa depôt was shifted to Reval, and the Czar seized Narva and opened the Baltic to English, French, and Dutch commerce. Sweden seized the fleet of Lübeck as it was returning from Narva and carried it to Reval and Stockholm. The war which ensued lasted eight years.[1] In 1579 the Danish fleet blockaded Hamburg and disputed the sovereignty of the Elbe. Spain's trade with America had been heavily financed by Flanders, and finally the Emperor Charles V united Flanders to Spain under Philip.

The Hanseatic League which had formerly looked to Prussia for protection and support, now looked to Spain, and the Court of the German Empire became largely dependent on Philip.

Philip had for a long time been meditating an attack on England, and had pressed the Hansa Cities to join him, but hitherto they had hesitated, because they did not trust Philip.

[1] Anderson—Vol. II, page 104.

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But the portents of the times could no longer be mistaken: the supremacy of the League had been disputed on many sides, its internal discipline and cohesion were menaced by revolt, and the rivalry of the English Merchant Adventurers promised to be the last straw on the burden of misfortune which was steadily accumulating on the back of the once all powerful League. There was only one way to regain the prestige of the Hansa Towns and restore the power of the League, and that was to crush the rivalry of England and humiliate the proud Queen who had dared to challenge the foreigners' right to exploit her country for the benefit of aliens. Accordingly the Hansa decides to cooperate in the great project of the Spanish invasion of England, and enters into a secret alliance with Philip to that end. Thus in 1586, Hieronomo Lipomano, Venetian Ambassador in Spain, reports to the Doge and Senate:— "The City of Hamburg which governs itself as a Republic, and is hostile to the Queen of England on commercial and other grounds, has sent a letter to the King of Spain offering him the port of Hamburg, which is capable of sheltering a large fleet. The King is also in treaty for the use of another port near Hamburg. Both will be of service to Flanders and for putting some check on the Queen of England.[1]

In the same year (1586) the Venetian Ambassador in Madrid secured a copy of an estimate of supplies and ships for the Armada which had been prepared by the Marquis of Santa Cruz, who had been designated for the command: this estimate includes thirty German ships and 12,000 Germans. Elizabeth was well informed of what was going on, as we can gather from a note in Burleigh's handwriting, to his friend the King of Denmark.[2]

The records show that ships and stores from Hansa towns, of which Hamburg was the most important, continued to pour into Spanish and Portugese ports during the years 1586 and 1587. Elizabeth threatened to treat the cargoes of these ships as contraband, but the Hansa pleaded that they were acting within their neutral rights, and refused to abandon the lucrative trade.

On 12 July 1588 the Spanish Armada set sail from Corunna, and on July 19th news of its approach reached England: a series of engagements terminated with the final dispersal of the great Armada at Gravelines on 29th July.

Philip even then did not despair, and set to work with the cooperation of the Hansa, to organise another expedition against England.

But on 30th June 1589 Drake seized sixty Hanseatic ships near the mouth of the Tagus and thus put an end for ever to the ambitious project of a second invasion of England with the aid of the resources and sea power of the League. After another eight years of constant strife and intrigue on the part of the League to regain its privileged position in face of the resolute attitude of the Queen of England, the Emperor Rudolph issued an imperial mandate giving the English

[1] "The Germans in England"; by Ian Colvin.

[2] Navy Records, Spanish War, 1585-1587.

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three months notice to quit the Empire. Great was the joy of the Hansa Towns at this edict, for they confidently expected that Elizabeth would speedily come to terms. But they had yet to learn of what stuff the Queen was made. The English Merchants established themselves at the Dutch town of Middleburgh, to await events which might turn out in their favour.

In 1598 the climax was reached by a Hanseatic attempt to hinder the export of grain to England and Holland, and Elizabeth issued an edict of expulsion against the Germans in England residing at the Steelyard, to be carried out within fourteen days. The Mayor of London attended by the Sheriffs, formally presented the royal decree to the authorities of the Steelyard, and took possession of the premises.[1] Ten days after the formal handing over of the premises, the Germans filed out of the Steelyard in orderly procession. The authorities wrote to the Hanseatic Diet describing their expulsion:—"After duly protesting against this forcible act, we marched out of the gate, the alderman at the head, and we following him, sad in our souls, and the gate was closed behind us. Nor should we have cared to remain another night within the walls. God be pitiful." Such was the end of German economic domination in England: may it never raise its head again.

[1] The property of the German merchants was not expropriated however. but was subsequently restored to German ownership, though not to the League in its corporate capacity.

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ARTILLERY TRAINING.

COMMUNICATED.

(Continued from No. 9, page 314).

ARTILLERY MOUNTED PATROLS WITH INFANTRY.

1. *Explanation.*

This article is written to help Artillery Commanders to train Officers' mounted "information" patrols. Also to indicate to Infantry Commanders how to assist such training, and adopt it for their own patrols. The REASON for such patrols is to help our infantry to obtain the artillery support they need.

The main duties in which these patrols should be trained are:—

(a) To find out the situation of our infantry; what their immediate objective is; and what, if anything, prevents them reaching that objective.

(b) To maintain close touch between the infantry and their supporting artillery.

In battle, when the situation is obscure, steps must be taken to clear it up. Artillery commanders, in default of personal reconnaissance, rely mainly on their F.O.O's. to keep them informed. An F.O.O's. party observing from an O.P. should be regarded as simply a "standing" patrol. When they can no longer clearly see the progress of our infantry they cease to be of any value and must go *further forward* in order to acquire information.

An F.O.O. and his party may then, for the time being, be regarded as a "moving" patrol.

When an artillery commander from any cause ceases to receive information from his F.O.O's., or when the situation on a portion of the front is obscure, he must either go forward and see for himself or send to find out. In the latter case he sends an Officer's mounted "information" patrol.

The strength of such a patrol varies with the tactical situation but will ordinarily be:—

1 Officer.
3 O.R., of whom two should be signallers.

all mounted and *armed*, but prepared to work on foot.

These patrols if boldly led and handled can work with impunity right up with the leading infantry and under certain circumstances in front of them. The speed at which they can move enables them to evade M.G. fire. It must, however, be clearly impressed on them that they are not to take part in the more picturesque incidents of the fight but to *send back information*.

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II. *Training.*

To obtain results, training should be carried out on the following lines:—

1. The first steps are:—

(a) MAP READING (small scale).

(b) REPORT WRITING.

These must be understood and officers and men must be made efficient in them. Develop the "Hunter's Instinct"—keep their eyes skinned and their ears open—make them use their wits. Do not drynurse. Encourage them to act with resource and initiative which should not degenerate into mere blind "go-aheadness."

Don't use the best men *always*, give the promising youngsters a chance.

When you use a good man, TRUST HIM.

2. The battle formations and general organisation of infantry should be explained in simple terms so that every man knows that a platoon is a body of men and has nothing to do with the crossing of a canal (pontoon).

3. Before beginning instruction EXPLAIN exactly what you are going to do. Then DEMONSTRATE it. DON'T EXECUTE any scheme until every man understands what you are teaching and *why* you teach it. Then, having carried out your scheme, make your criticisms and REPEAT. Give your men a REASON for what you teach them.

4. Opportunity must be seized of sending out Artillery Officers, accompanied by men under instruction, when a battalion is carrying out a tactical exercise. They should be sent forward at intervals to report how the infantry are disposed on the ground, what they are attacking, and by what they are opposed..

The patrol officer should see battalion and company commanders, write reports and send them back to some pre-arranged spot. This spot will change from time to time as the battle develops.

At the close of the exercise the action of the patrols should be criticised and corrected, and their reports checked.

5. Infantry officers are accustomed to having artillery officers for liaison in trench warfare, but, as they seldom have a chance of training together in the back areas, battalion commanders do not yet understand that observation over the battle ground coupled with communication to the guns is the most practical form of liaison, and that visits from an Artillery Officer's Patrol in the course of a moving battle replace the "Liaison Officer" and give excellent results.

6. To carry out the training of artillery patrols, the assistance of the Infantry is necessary. To make it real, infantry commanders should ask for patrols to come and practise with them whenever a battalion or any larger formation is carrying out an "open warfare" attack scheme. The infantry should be taught that these patrols are out on business and are there to help and should be supplied with information at all times.

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III. *What a Patrol should be told before starting.*

7. The instructor should place himself in the position of the officer who is sending out the patrol, should see its commander personally and give him definite instructions. Tell him first *why* he is being sent out, and on what point information is *specially* required. *Don't* be sketchy, don't be vague.

The patrol will often be sent out to bring back accurate and definite information on one special point, for instance: "What line do our advanced infantry hold between the villages of "Q" and "R", or, "Our advance just E. of village "W" is "sticky". Where does the opposition come from?"

To send out a patrol merely to "find out the situation" is a sign of an untidy and lazy mind.

The most accurate and effective method is to ask the patrol to reply to a series of questions, any one of which must be replied to by the word "Yes" or the word "No".

8. The patrol commander should be told:—

(a) All that is known as regards the situation on the front he is concerned with.

(b) Where our infantry are *known* to be; where the *rumour* is that they are; where the enemy *is*; where he is *not*; where he is *suspected* of being.

(c) Where Battalion and Company H.Q's. are likely to be found.

(d) The situation on our flanks.

(e) In each case *at what time.*

(f) Where he is to return to on completion of his mission.

These matters should be pointed out to him on the map and, when possible, on the ground.

9. Make sure that the patrol commander knows the lie of the land. It will help him to know what localities the enemy has lately been shelling, for such localities are presumably *not* occupied by hostile troops.

Observation of the enemy's shelling will give him a guide as to how far he can go without over-running our leading infantry.

10. An important point is that the patrol commander should know the degree of urgency of his task. Is the situation serious and is the necessity of an *immediate* report paramount?—in that case he may be ordered to ride back *himself* with his report.

11. Will the commander who requires the information be in the place he is now at —— if *not*, where is the report to be sent to?

NOTE:—A battery which has sent out a patrol should, on changing position, leave a man in the old position to direct the patrol to the new one. This point should be seen to in all training schemes.

12. In giving the patrol commander his orders be sure you tell him what will be of use to him—make the job as simple for him as you know how. To get the best results he must have views as to what he wants and what he is going to do, and must give crisp, clear and definite orders to the men of his patrol.

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His task is by no means an easy one. It requires not only courage and good luck, but demands an eye for ground, a clear head, rapidity in drawing deductions and in forming decisions from them, and considerable acquaintance with infantry tactics.

13. Previous TRAINING is therefore *essential* and every battalion commander should go out of his way to obtain artillery patrols on his field days.

IV. *How a Patrol should carry out its task.*

The following points indicate the general lines on which a patrol should be trained to EXECUTE its task:—

14. The patrol commander on receiving his orders should make sure he understands what is required of him. He must not hesitate to ask questions to clear up any uncertainty. He studies his map and the ground and makes up his mind (*before starting*) what he is going to do.

15. He then rides forward as far as he safely can, dismounts, tells one man to come with him and leaves the remainder under cover—telling them what *he* is going to do and what *they* are to do if he does not return or send them a message by a certain hour.

The signallers left with the horses should endeavour to open up communication with their battery or brigade.

16. He goes on with his orderly—on foot—sees the infantry commander on the spot, and works out on the map and with this commander what the available information amounts to. If this is insufficient, he goes forward until he finds out *with his own eyes* exactly what is going on.

In every case, whether the information is acquired from another person or due to his own eyesight, he must note the *time* at which it is obtained.

17. In order to pick up news, he will ask questions of anybody he sees on his way.

The Section Commander of any forward section of guns can give valuable information. The Patrol Commander must not however waste time in listening to stories of daring exploits earlier in the day; what he wants to know is—the situation *now*, not what it *was*.

18. Walking and other wounded may give news. This will be "scrappy" and will require weighing and perhaps rejecting as not sufficiently reliable, but as he probably catches these men near the spot where they were wounded they can point out localities to him and their information may lead to a coherent tale.

19. He may find difficulty in getting some infantry officer to tell him anything at first. This can be got over by explaining who he is and what he is after. The infantry will only be too glad to help when they know that the receipt of this information by the artillery commander will enable artillery support to be increased and fire brought to bear where it is needed.

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20. In spite of these endeavours he may still be in doubt as to the exact locations of our own and the enemy troops.

BUT by this time he knows that our men are at *certain places*—beyond that the situation is doubtful. The enemy however is certainly *somewhere else*, and if he sees for the moment no reasonable chance of getting more definite news he must be content with that.

He can produce a report giving *positive* information on at any rate a portion of his orders.

He can also give definite *negative* information as e.g., "At 1015 the enemy were *not* holding White Chateau"—or, "At 1025 our men were *not* at the W. edge of village X". This he writes and sends back.

As a result of such a report the artillery commander will know that he can fire within certain limits and can arrange accordingly with his F.O.O's.

NEGATIVE INFORMATION IS OFTEN AS VALUABLE AS POSITIVE NEWS.

21. The patrol commander's duty then is to send back information on the lines already indicated.

In addition to this he should—*but only if time permits*—send back information which might be useful from the artillery point of view with regard to the subsequent advance of batteries.

For example:—

(a) "Ground in squares X 15 a and c is wet and boggy".

(b) "The crossing by bridge at ESTREES is not fit for artillery now (1225) but the ford 200^{x} north of it is passable. R.E. are working at the bridge".

(c) "Ground in S. portion of P 12 d is a suitable position for *one* battery".

(d) "From the cross roads at X eastwards to "M" there is good going for guns *off* the road on the south side".

(e) "Good watering for horses in stream at N. edge of village "Y". 50 horses at a time".

V. *Messages and Reports.*

22. To write clear, concise and legible messages or reports requires TRAINING. Such things cannot be done by the light of nature. The instructor must impress the following points on those whom he is training.

23. Never forget to mention the *time* at which you saw a certain event occur or at which you were told of it.

24. The *source* of your information must be stated: also the amount of *reliability* which can be attached to it.

For example:—

(a) "At 1100 I saw our infantry enter GREEN WOOD from the West. I have not yet (1127) seen them emerge. I can see all exits from the Wood clearly".

(b) "O.C. 17th Battalion states that at 1045 his leading platoon was ejected from house and garden at H. 16. c. 7.5. He intends to re-take it again at 1130 using T.Ms."

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(c) "1330. Wounded men of 18th Battalion say the attack of their battalion on YELLOW FARM succeeded and that our men are now E. of it. They have just come from YELLOW FARM. One of them, a corporal pointed out the actual Farm to me".

(d) "I can see (1445) from house at P 3 d. central that our infantry are digging themselves in on N. and E. sides of BLUE CHATEAU".

25. It may be necessary to repeat or confirm messages already sent. It is often of the utmost value for a commander to know that our troops or the enemy, as the case may be, are *still* in a certain place at a time later than the original message.

For instance—

"1515—My number—message. Our infantry which entered GREEN WOOD at 1100 are still there. One of my men has kept the Wood under observation since that hour and has seen no one come out or go in. The enemy has been shelling the E. edge of the Wood lightly with 77's since 1300".

26. Number your messages on a system; use your own initials; for instance begin with AB. 1, continue AB. 2, AB. 3 and so on.

NUMBER all messages consecutively.

Use the message form C. 2121 (the white field telegram form) and fill in all the headings. It will remind you to enter TIME and PLACE.

When your message is sent through a Signal Station enter the TIME of the report in the actual *text* of the message (vide messages (a) and (d) in para. 24 above), otherwise the time at the bottom of the message form is liable to be altered at the Signal Station to denote the time at which the message *was handed in.*

Use carbon paper and so keep a copy of each message.

Have some small envelopes in hand to put your reports into; this may prevent your messages arriving crumpled up and hard to read.

27. Make your report clear and complete. An ill-written, badly expressed, ambiguous message which is not timed is either a danger or so much waste paper. Your Brigade or Battery Commander wants to act on your report: more than that, the movement of many troops may depend on its accuracy. Remember that if your message is clear and useful *and arrives in time* it will not stop at your Battery or Brigade Headquarters but may lead to an important decision being given by the higher command.

28. Give all information you can glean as to what is happening on the flanks—although it may not seem much to you it may corroborate other reports and be of value to the commander in rear. Also state any action which is to be taken by a local commander on the ground.

VI. *How to get the Reports back.*

29. Reports and messages however good are not of much use unless they reach their destination and reach it *in time.*

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30. As a patrol commander responsible for getting information back, there are four methods you can use:—

I. Go yourself.
II. Send a written message.
III. Use "Signals".
IV. Send a verbal message.

I. If you have completed your mission; if you have got valuable information which you can best explain personally and on which you think your commander may base an important decision, then go back yourself. Don't hesitate about it—GO—and GO QUICKLY.

II. If you feel that, although your information is good you are likely to get better news in, say, half an hour's time, write a report, and send it back by your orderly to where the horses are with an order to one of the mounted men to take it back to your commander.

III. Your signallers may have been able to establish visual communication. If they have, they should use it. Make use also of any existing signal systems you find in the vicinity—such as those with Tanks, &c. Avoid using up your horses—but don't forget that the horse was made before the telephone and in moving warfare is generally a better means of communication.

IV. Never send a purely verbal message if it can be avoided. At the same time tell any message-carrying orderly what is in your written report *and make certain that he understands*, so that he will have the gist of it in his head.

31. The orders you received before starting should make it plain which of these methods is best for you to adopt but the main point to remember is that it is your duty *to get information back* and to get it back *in time*.

32. A patrol which starts on its errand at dawn and returns at dusk with a mass of stale information has done nothing to help its unit to KILL THE ENEMY and has consequently failed in its duty.

33. Once the battle becomes stationary, horses can be dispensed with, the patrols become "Standing" patrols, i.e. F.O.O's parties, and a system of communication is established.

Officers and men should be trained to adapt themselves equally to either situation and to pass from one to the other with facility.

Therefore battery commanders should demand of their infantry comrades facilities for training patrols in the back areas.

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Contents of R.A. Journal, February & March, 1919.

With the Field Artillery from Trench to Open Warfare on the Western Front. By Lieut.-Colonel W. H. F. Weber, D.S.O., R.F.A. 357

Echoes from the Mess Table—and elsewhere. No. II. By "Henry Clay". 363

The Battle in Palestine. Commencing August 19th, 1918, as seen from the R.G.A. advancing in support of the Left Flank. By Lieut.-Colonel F. P. Hutchinson, D.S.O., R.G.A. 370

Gaudia Centurionis or The Instructor of Zeitûn. Illustrations by Major J. F. Fogerty, R.F.A. (T.). Verses by Lieut. H. C. Hughes, R.F.A. (T.). 375

The Employment of Officers in Topographical Surveying. By Major R. H. Rowe, D.S.O., M.C., R.G.A. 387

"A Tough Lot." By Major General J. B. Richardson, Col. Comdt., R.A. 390

Artillery Pack Saddlery. By Capt. (actg. Major) F. C. A. Troup, R.G.A. 393

The Rapid Calculation of Switches from an O.P. without a map. By Major S. R. Normand, D.S.O., R.G.A. 397

Some Old Gunnery Experiments. By Major T. W. Saidler, R.G.A. (T.). 402

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WITH THE FIELD ARTILLERY FROM TRENCH TO OPEN WARFARE ON THE WESTERN FRONT.

By Lieut.-Colonel W. H. F. Weber, D.S.O., R.F.A.

"AWAKE! for Morning in the Bowl of Night
Has flung the Stone that puts the Stars to Flight."
Rubáiyát of Omar Khayyám.

I. NOVEMBER, 1917.

NOVEMBER 1917 found the British Artillery in the throes of Position Warfare and exhausted by the terrible struggle for the Passchendaele Ridge.

Control from behind, admittedly necessary for the management of a large mass of artillery (so long as communications hold), was at its height and threatened to submerge the individual. This control was assisted by the limitation of objectives at that time in practice.

So long as there were guns to fire and men to fire them, the chief consideration was sufficient ammunition. An important part of the artillery was Trench Mortars. The map, the compass, and the meteor telegrams ruled us. Observation was limited to a little sniping of individual movement and to the location of hostile gun-flashes. Reconnaissance and patrolling were unnecessary and non-existent. The individuality of the sub-commander was confined to the avoidance of hostile counter battery fire.

Consequent upon assiduous liaison provided by the artillery and owing to good communications, the infantry had learned to expect a standard of artillery support that could not be maintained under other conditions. As co-operation by the infantry was unnecessary, infantry officers had possibly forgotten that the word co-operation implies mutual help.

The lives of the 18-prs. were being rapidly shortened by continual barrages and battery commanders were getting anxious as to the accuracy of such of their guns as escaped damage due to hostile fire. Our 18-prs. were hopelessly outranged. Strengths were mostly much below establishment.

Under such conditions, the Heavy Artillery, a growing giant, had assumed the artillery offensive work, while the Field Artillery performed merely protective duties in attack and defence.

Almost one might say the Field Artillery on the Western Front had abrogated its mobility; its tactics were those of Siege Warfare. Yet this was not quite the case; for in some R.H.A. units open warfare was constantly practised; and at our Schools, where voices from Mesopotamia and Egypt were heard, a just appreciation of Open Warfare was taught. An opinion is widely held that more instruction could have been given at those schools on F.O.O's duties.

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II. CAMBRAI.

Came the battle of Cambrai. Considered from a point of view of the re-evolution of field artillery tactics, this battle was decisive. It's preliminary features were (a) the employment of tanks on a large scale which considerably lessened the importance of the creeping barrage; and, more important to us, by far, (b) the field artillery came into action on positions previously resected, at the very last moment, and without firing a single registering round. A repetition of these tactics brought with it a better understanding of the importance of sorting ammunition in backward areas.

The events between 20th November and 5th December are well-known. Our attack met at first with a measure of success; we created a big salient; but the cavalry failed to break through and an attempt to widen the salient to the North met with violent opposition about Bourlon Wood. On the 30th November the Germans counter-attacked on the right or Southern flank of our new salient, and actually penetrated to Gouzeaucourt. Another counter-attack on the Northern flank of our salient brought about a tremendous struggle and ended in a bloody repulse for the Germans; but in spite of this success, we were compelled to give up a good deal of the ground gained, very largely owing to the successful use of gas by the enemy against Bourlon Wood. We learned our lesson—so did the enemy.

One result of the battle was that we began to exploit the use of gas shells, but the armistice has come before we have been able to get full benefit from that exploitation.

Cambrai brought us the term 'Counter-preparation' with all that it meant to the artillery during the next 12 months. Of infinitely more importance was it that we got our first 'refresher course' in open warfare. Group and Battery Commanders found themselves, with the breakage of communications, deprived of guidance from behind and of information from their O.P's. Infantry failed to get the accustomed answer to their wishes from their supporting artillery.

To those (of *both* sides) engaged about Gouzeaucourt, the lessons learned were far-reaching.

III. PREPARATIONS FOR THE GERMAN OFFENSIVE.

About this moment it dawned on the rank and file of the British Army that they would shortly have to withstand an attack on a first-class scale. It is of importance to realise that only a small proportion of the artillery had received first-hand impressions of the Gouzeaucourt fighting.

Of 'Defence in depth' and 'Silent batteries' much was written. In practice, the 'depth' was insufficient and the principle of 'silent batteries' was not thoroughly understood. The two are closely allied.

Presumably, it was hoped to defeat the enemy onslaught before he penetrated what became known as 'The battle zone'. The essential for the employment of artillery in the defence is safe (i.e. *buried*) communications. Labour was devoted to miscellaneous excavation which would have been better employed on the construction of 'buries'.

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Should this first-line defence fail, it would be necessary to fight a withdrawing battle; artillery positions in rear were as necessary as infantry lines of defence. It does not seem to have been realised that the lines held during withdrawal might not follow exactly the contemplated infantry defence lines. The positions prepared for artillery presumed that we should be holding certain well-defined lines; put into other words the rearward battery positions should have been made in the light of an open warfare battle, which few people then understood; they should have been *in depth* and not parallel to the preconceived line of defence. Further, an exaggerated value was placed on excavation; the writer had under him at the time a battery composed almost entirely of miners; the work of this battery was advertised as the last word in artillery positions. This was, in truth, a misconception. These positions had been quickly and well dug, and were brilliantly organised; most of them were never occupied, and labour was wasted, which would have been of untold value in the preparations of 'buries'; such 'mined' positions are actual traps—they attract B.C's (though they do not suit the tactical situation of the moment) and, like fortresses, once entered, they are difficult to evacuate. It was the result of 'Trench Warfare' ideas; and perhaps also the desire to have something to show. What then is necessary? it would seem that rearward positions should be resected and their positions carefully noted, so that batteries do not clash—especially so that Heavy and Field Artillery do not clash. If there is time, a fighting-map is worth making for each position—subject to the proviso that it can be got at when needed. Observation *on a mobile-warfare basis* must be arranged; a simple battery headquarters giving shelter from weather is a convenience, as also is a little ammunition. A mine is quite beside the purpose; the one essential is that the whole area be known to the personnel of the batteries which may have to occupy positions therein.

The possibility of enemy use of tanks had to be considered. It was considered, not without justice, that the existing wire would hold up any attack unsupported by tanks. We had nothing but theory to work on. And indeed—the best method of meeting a tank-attack is still largely based on theory.

The object of 'silent' batteries was to avoid their existence being known to the enemy. They must therefore be concealed. Camouflage was a practical impossibility on the plains of Picardy. Elaborate entrenchments did more harm than good. More batteries should have been "in observation" ready to move into other positions (studied to the utmost detail) when the alarm was given. Similar tactics met with great success in General Gouraud's army, east of Rheims on 15 July.

Some Defence Schemes did not sufficiently contemplate the breakage of communications. The policy to be adopted as to continuance of fire on S.O.S. lines after (say) a quarter of an hour was not in all cases laid down at that time. The moment at which forward sections or batteries should withdraw was evidently not appreciated by some officers. It is possible that the Defence Schemes were insufficiently studied or applied to local circumstances by artillery sub-commanders in the line.

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Did the Germans speak fairly in saying that the British Artillery was gallantly fought but badly directed.? For one thing, that portion of the Heavy Artillery allocated to the defence of the line was in communication with Field Artillery Group Commanders only where the energy of individual sub-commanders of R.F.A. and R.G.A. had brought into existence private means of liaison. The employment of the Heavy Artillery depended too much perhaps on control from behind.

Finally there was insufficient artillery in many parts of the line to put up a proper S.O.S. barrage; where the writer was in March, there were only 2 18-pr. batteries and 1 4·5″ howitzer battery to cover a wide Infantry Brigade front; the value of long-range fire was perhaps underrated; field batteries might have been further distributed in depth; and the effect of the 6″ Howitzer shell with 106 fuze was overestimated.

IV. THE GERMAN OFFENSIVE.

The fateful 21st March arrived and the much (too much) talked of German attack was delivered. G.H.Q. and the outposts may have known it was coming, but the cry of 'wolf' had gone up too often and there must have been many who did not take the warning seriously until the bombardment began. In some places, the counter-preparation which had fatigued the artillery on so many previous occasions was not repeated.

On the writer's front, the bombardment opened at 0355 hrs. and he was at once convinced. It is not yet possible to say when and where and how the attacks were delivered. Within a few minutes all unburied communications were broken; from O.P's. no more was heard and most of the F.O.O's were next heard of from Germany; the bombardment was not so intense as it was well distributed; all battery positions, silent as well as active, were swamped for a time with fire and a considerable proportion of the guns put out of action; also there was a thick mist.

Forward elements of our artillery found themselves in the mist firing point-blank into the German infantry or being machine-gunned from a flank; some positions were captured from the rear. In some cases batteries were caught in the traps made by themselves in the shape of over-elaborate excavations; a more common occurence was that the teams could not be summoned early enough from the distant wagon-lines and the battery personnel, having gallantly fought the guns to the last possible moment, destroyed the pieces and fought their way out with rifles.

The Heavy Artillery batteries cut off as regards instructions from behind, mostly placed themselves at the disposal of the Field Artillery Group Commanders, and did splendid service. All along the line occurred scenes of the utmost gallantry and devotion, which equalled, if they did not surpass, the finest traditions of the Royal Regiment; the V.C. must have been earned over and over again on the 21st March.

Under cover of darkness, what remained of the batteries in the line was withdrawn for defence of the next position, and for which reinforcing units were already in position.

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For a short period fighting similar to that on the 21st occurred, though comparatively few guns were lost after that date. Gradually our battle zones were lost and with the retreat of the Third and Fifth Armies, open warfare came into existence.

The artillery adjusted itself to the new conditions, though years of Position Warfare had cramped its style. The great difficulty was to make the infantry (brigadiers and battalion commanders) understand what was practicable and what was not practicable. It is impossible to move a group of artillery to a destination several miles back, to organise the group in its new position there while still remaining with the infantry headquarters, to answer S.O.S. calls in support of a line which nobody knows, without communications and with only the most hastily arranged observation. The demands were often quite impossible to comply with, which was probably due to the fact that over three years of stationary warfare had produced an erroneous conception of liaison, and that a surprisingly small proportion of senior infantry officers remained who had pre-war training.

The writer got out of the whirlpool with four fixed ideas—(a) to fight in future by the eye and not by the map, (b) to use his horse or feet for liaison purposes whenever he could escape from infantry headquarters, (c) to make extended use of patrols for security and information, (d) to treat the wagon-line as part of the battery, and not as a separate echelon.

Similar features seem to have accompanied the German offensives in Flanders in April, and on the Aisne in May and June.

An interesting point to discuss would be the comparative merits of withdrawing by sections within the battery or by batteries within the brigade. In spite of the increased difficulty to the B.C. as regards control of his battery in two places, the writer is inclined to favour the first mentioned system on the ground of procuring earlier efficiency on the new position.

He would very much like to know how other Group Commanders arrange for the construction, etc. of a Group O.P. when conditions do not allow of each battery making and manning its own.

V. THE ENTENTE OFFENSIVE AFTER JULY 18, 1918.

During May, June, and the first half of July, the British Artillery had time to consider the problems put before it and to digest the lessons learned. Crushing repulses administered to the Germans in Flanders on April 29th and some other dates prepared the way for the reaction at the end of July. Those who were in touch with opinion 'in the line' will never forget the revulsion of feeling which immediately followed Marshal Foch's success on the Marne and the 1th Army attack early in August.

It is as yet too early to discuss the grand offensive from an artillery point of view. The principal feature was the exploitation of Surprise by dispensing with all preliminary bombardment. Amongst other things we witnessed may be quoted:—.

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(a) The rapid organisation on the simplest lines of creeping barrages at as little as 1 to 2 hours notice.

(b) The employment of forward guns in the advance. In this matter, it is suggested that as such a detachment requires officers for observation, liaison, and command of the guns, it is better to employ whole batteries (less 1 section) than single sections.

(c) The advisability of Infantry and Artillery commanders being together and the need for the study by the Infantry of Artillery communications.

(d) The exploitation of Artillery Reconnaissance.

(e) The new mobility attained by the Heavy Artillery.

(f) The disappearance of Trench Mortars.

The writer never ceased to impress on those placed under his command to 'shoot themselves in' directly a new position was occupied and to use their eyes rather than their maps; never to dump a round or lay a wire until there appeared need thereof.

But it was not always movement; there was still at times even the defence; and an artillery commander has to question himself at all times as to whether he is fulfilling these 9 conditions of artillery support.

These are:—

(i) Good equipment, kept in order—sights tested.

(ii) Comfort and safety of detachments—implying a system of relief and protection against weather, shells, and gas.

(iii) Good gunnery, which includes study of theory, knowledge of range tables, training of detachments, sorting of ammunition, calibration, and calculation of meteor effects.

(iv) Good observation and good F.O.O's.

(v) Good communications; for a big group on the move a D.R. is really a necessity.

(vi) Good liaison with the infantry; *in this the infantry must please help.*

(vii) A workable system of command, which includes control within the battery. A Field Artillery Brigade Staff cannot efficiently manage a group of more than three brigades. To make a sub-group of one's own brigade with an improvised staff has many objections.

(viii) Distribution suitable to the tactical situation, which includes alternative positions.

(ix) Mobility.

These points keep on recurring over and over again, so that one is tempted to quote Robert Louis Stevenson "There is something almost stupefying in the recurrence of unimportant things"—only that they are not unimportant. The Trees threaten to obscure the Forest. The Trees are short shells, breakages in communications, casualties, unfair criticism, etc. The Forest was our determination to help the infantry win through.

* * * * * *

This paper was written on the way to the Rhine, one year (almost to a day) after the commencement of Cambrai.

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ECHOES FROM THE MESS TABLE— AND ELSEWHERE.

No. II.

By "Henry Clay".

"AFTER the War" problems are obviously exercising the minds of soldiers every whit as much as of the nation at large. One seldom witnesses the meeting of two friends without hearing the query "And what are *you* going to do after Peace is signed?" In most cases it appears the impulse is to get as far away from England as possible. It is said that more Officers have applied for India than will be required there; whilst if all the words one hears are going to be translated into deeds, the Colonies will be thronged to overflowing by retired warriors. This instinct for migration is largely due doubtless to the fear of the maintenance of the high cost of living at home, coupled with the prospect of the loss of Field Allowances, rations and so forth. Scales of pay, in fact, are coming increasingly under discussion as Peace approaches, and the Government is giving the subject serious attention.

It is often pointed out that Officers receive perquisites in the shape of quarters, fuel and light, medical attention, etc. which should in justice be taken into account in estimating their financial position. It might be of interest to work this idea out in detail and investigate results. I have accordingly done so on the attached table, from which it will be seen that the total cash value shows a considerable increase on the advertised rates of pay. The values shown in the Light, Lodging and Forage Columns are based on the Cash allowances as authorised in lieu in 1913. The Lodging Allowance has been taken as the approximate value of the quarters allowed. It is true that the type of quarters allowed for Captains and Subalterns is the same, whereas the allowance for Captains is nearly £5 more. On the other hand unmarried Captains are frequently able to occupy Field Officers Quarters of two rooms which would be worth generally about £1 a week. So I have allowed the discrepancy to stand. The Fuel Column shows the cash equivalent of the Coal allowance calculated at the average pre-war price of 27/6 per ton. (I hope my arithmetic will bear scrutiny).

£5 is the cost of a Medical Policy which assures one roughly the same benefits in civil life as one receives free in the Army Servants are calculated as being worth 25/- a week, less the authorised remuneration of 10/- a month.

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The annual value of the Pension requires some explanation. It is not possible for an Insurance Company to quote a policy which will cover all the advantages of the Army Pension Scheme. I have therefore worked out the Annual value of the Lieut.-Col's. pension of £450 a year and the next highest pension of £300 a year for other Officers, in the following way. The Compulsory age of retirement for a Lieut.-Colonel is 55. At the age of 55 a man can buy an annuity of £150 per annum for a cash payment of approximately £6,000. To receive a cash payment of £6,000 at the age of 55 a man would have to pay £140 10s. per annum from the age of 21. I therefore consider the Lieut.-Colonel's pension of £450 has been worth £140 10s. a year to him throughout his service. These figures are taken from the tables of the Clerical, Medical and General Life Assurance Society.

I have not included in the table any references to the horse a mounted Artillery Officer is entitled to, because he is not free to use it as he wishes unless he pays the Government £10 per annum. But whether he hires his charger or not the forage is free and ought to be reckoned with.

The totals arrived at represent, I think, the most that an ardent supporter of the thesis could claim. But it is evidently unjust and untrue to say that the pay and perquisites of a 2nd Lieut. are equivalent to a salary in the Civil Market of £484 18s. 2d. per annum. For some of the unavoidable expenses of the Subaltern are roughly as follows:—

	£	s.	d.	
Mess Bill	8	0	0	(A low estimate. On a pre-war scale).
Servants	1	0	0	
Washing	1	0	0	
Cleaning Materials		10	0	
	£10	10	0	

His monthly receipts are £13 (less income tax), and not including the weekly bonus now allowed.

Obviously no man receiving £485 a year would so order his expenditure that he found himself, if lucky, left with less than 30/- a month for clothes and incidental expenses. On the other hand his prudence would be unlikely to extend to the putting aside of £127 or £140 a year in an Assurance Policy. If he did (one must admit admiration for such a man), he would certainly not spend £118 a year on servants. In fact, a man in civil life with such an income paid in cash can live in comfort without other resources. A man in the Army, paid partly in cash and for the most part in kind, cannot.

I say that he cannot live in comfort. One should not say that he cannot exist because it has been done. How it is done has always been a mystery to me personally—how it is done at home, that is to say. The effort generally ends in an enforced withdrawal to one of the African Colonies where increased pay, together with decreased opportunities for spending it, and generous leave conditions, offer

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considerable inducements. Even there it is understood the opportunities for spending tend to increase with the growing transport facilities and with the consequent possibilities of a more luxurious standard of living than has prevailed hitherto.

The West African Colonies, however, are the last resort. Before that necessity is forced on one, India of course offers conditions of a less strenuous financial nature than England. There are certain dangers, it is true, in the complacent attitude of the Native money-lender. It is unpleasant to hear of men being unable to leave the country without the gracious permission of some oily "Srof". There is the story of the Officer of an over-generous nature, who having exhausted the money-raising possibilities of the home country, found himself unwillingly bound Eastwards. On arrival at Bombay the ubiquitous native banker boarded the vessel and expressed his willingness to honour the heaven-born Sahib's signature to any amount. When the heaven-born had recovered from his astonishment, he seized a telegraph form and wired to his brother in London. "Come out at once" he said. "Man here wants to lend you money."

To foretell exactly what the financial conditions in India will be in the future is impossible. The cost of living has risen there as elsewhere and a coming fall in prices remains a pious hope. It may be of interest to young members of the Regiment to hear what the rates of pay in India are and I have accordingly translated the monthly allowances in rupees into £ s. d. (approximate):—

	£	s.	d.
Lieut.-Colonel	60	15	0
Major (24 years service)	55	6	6
Major (on promotion)	52	0	0
* Captain	32	0	0
Captain (on promotion)	29	0	0
Lieutenant (6 years service)	21	13	1
Lieutenant (on promotion)	20	0	0
2nd Lieut.	16	13	4

* 3 years service as such and 12 years service in all.

The pay is at a consolidated rate and no quarters are allowed nor issues of fuel and light made. I believe I am correct in saying that a married couple (without children) can live for about the same amount as a bachelor.

Having placed the Home and Indian rates of pay on paper, one is naturally led to compare them. Having been thus started, I feel I am being led into a perfect orgy of figures. But the point is one of such interest that I am emboldened to see it through. It lies in the estimates of the British and Indian Governments on the comparative values to the State of British Officers of different ranks. For instance the Indian authorities consider that a subaltern of 6 years service is worth more than one of three years service. Both Governments have adopted a scale which differentiates between Captains and Majors on promotion, and the same officers after a few years service in those ranks. But the difference in

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the appreciation of the added responsibilities and importance of the Battery Commander is so striking as to deserve attention. The comparison can best be made by expressing the increases in each rank on a scale in which the Lieut.-Colonel's increase over the 2nd Lieut's pay stands as 100 and the other officers in proportion. It is important to notice that the scales represent the *increase* in pay and not the rate of pay.

Proportional Representation of the increases in an Officer's pay from 2nd Lieut. to Lieut.-Colonel.

	At British rate.	At Indian rate.
Lieut.-Colonel	100	100
Major (24 years service)	65.5	90
Major (on promotion)	51.5	82
* Captain	41.5	35.5
Captain (on promotion)	34.5	28.5
Lieutenant (6 years service)	7	11.5
Lieutenant (on promotion)	7	7.75
2nd Lieutenant	—	—

One cannot help suspecting on studying this table, that the responsibilities of an Artillery Major as Battery Commander have not received at home the attention they deserve; and that the Artillery scale was based on the Infantry scale, in which it had to be remembered that an Infantry Major, on promotion and until he becomes 2nd in Command, performs the duties of a Captain and commands a company. The injustice to the Artillery Major is obvious. The suspicion is confirmed to some extent by the fact that the Indian rates for Majors of Infantry are £52 and £48 13s. 4d. respectively. The differences between these rates and those for the R.A. represent the Command pay of the Battery Commanders.

The question of the Officers pay has already attracted attention in the newspapers and "The Times" recently had an article suggesting various perquisites such as rations on payment, travelling at reduced fares and so on. Acceptable as such advantages would be, they would not solve the Subaltern's financial difficulties. If unassisted by private means, his expenditure can scarcely fail to exceed his income. Nevertheless, generally speaking, he refutes the truth of Mr. Micawber's immortal dictum "Annual Income Twenty Pounds, Annual expenditure Nineteen nineteen six, result happiness. Annual Income Twenty Pounds, Annual expenditure Twenty Pounds ought and six, result misery."

But then Dickens was reckoning without that great philanthropist, Mr. Cox of Charing Cross.

* * * * * *

Rumour continues to be rife regarding a re-amalgamation of the Horse, Field, and Garrison Artilleries, after a separate existence of just 20 years. The reasons which led to the separation have never been published, the report of the Committee which dealt with the

* 3 years service as such and 12 years service in all.

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matter in 1898 not being laid before Parliament. One of the arguments adduced at the time in favour of amalgamation was that the Garrison Artillery would constitute a valuable reserve to the Field Artillery in time of War, if their Officers had a Field Artillery training. For (so it was urged) the Garrison Artillery could never by any possibility be involved in any future War. It was only a year later that Garrison Companies found themselves tramping behind Long Toms in South Africa. Even then the expansion which lay ahead of the R.G.A. in 1914—18 was undreamed of. Thus one factor which appears to have been considered worthy of consideration in '99 has dropped out of the case.

The main reason given for the change by a writer in the U.S. Magazine was that the R.G.A. should "stand on its own feet." He was very gloomy about the future outlook for the Garrison Gunner however—"a chained Watchdog" who would look on and play nothing but a spectator's part. The only way out of the difficulty that he could see was for all the Coast Batteries to be handed over to the Navy. But the suggestion was made without any illusions as to what the Navy would say about it. Another view was that the R.G.A. would gain from the continuity in training of the Officers but lose in point of smartness accruing from contact with the Mounted branch through constant interchange of Officers.

It is natural that public interest in Military matters should have widened as a result of war. Such interest received a stimulus during the South African War, and the recruiting by journalism of military writers of experience, produced articles in the Daily Press of great value during the succeeding years. Some of the topics dealt with were referred to here last month. A review of them would shew a wide range, including such problems as Food in War Time, the supply of Horses, Organisation of Motor lorries for rapid requisition in an emergency, reorganisation of the Cavalry and so on. How slight was the interest of the public before the South African War, will be realised from the fact that an Army Order of such importance as the division of the Royal Artillery into two branches was published by the "Times" on its appearance in June 1899 without one single word of comment.

* * * * * *

One of the consequences of the Nationalising of the Army is that men who were profoundly ignorant of War in 1914, and have since then been growing partially familiar with some aspects of it, are convinced that they now know all about it. This would not matter much if they were not better qualified than most soldiers to catch the public ear. Nor have soldiers ever considered it their duty, while serving, to catch the public ear. To some extent this may be a mistake.

One feature in current criticism is a distrust of that elusive body known as the Military Experts. There is a belief expressed in some quarters that Regular Officers as a whole are behind the times, conservative in their views, and obstructive of progress. It is desirable that the Nation should realise the amount of progressive thought

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which was operating in the Army before the War, has governed developments during the War and will doubtless continue to make its influence felt. The best means of combating the hostile criticism referred to is to see to it that no suggested improvements meet an unsympathetic reception and that military thought embraces readily all discoveries and inventions which can subserve it. We must allow no justification for such strictures to exist. It is not desirable that Regimental Officers should rush boldly into print and challenge the critics in their own arena. It is most desirable, however, that they should freely express their views on any and every subject of Military interest in their own Regimental Journals. For those Journals help to keep the professional Military Journalists, who for the most part are ex-Regular Officers and have studied War all their lives, in touch with current Military thought. These are the men on whom we must rely to place a sound outlook before the Public. As General Breeks says in the November number of the Journal, do not let us confine ourselves in our Regimental Organ to subjects of purely technical interest.

To keep abreast of the times, however, is getting increasingly difficult. Even since the Armistice was signed, an announcement has been made by the American Telegraph and Telephone Company that a new Multiplex installation has been designed, which enables one wire to do the work of ten used heretofore. A pair of wires carries five conversations simultaneously, or forty telegraph messages. I am quite prepared to accept the fact, but to understand it is beyond me. Yet I have an uneasy feeling that I shall be asked to understand worse things than this before many years are passed. One picks up a Text Book on Electricity and learns that it is useless to pursue the subject beyond the introduction without possessing a working knowledge of the Differential Calculus. As it appears that we are on the threshold of the "Electric Age" this is most discouraging, especially as Science is coming increasingly to the fore in every branch of life. Not long ago an eminent Professor stated that he had established the fact that "Love is the Energy of Integration which makes a Cosmos of the Sum of Things." So now we know. And to think that we had never realised it in all these years. Probably Don Juan pursued his hobby to the end without ever really knowing what he was looking for.

But to return to Electricity. Can no one come to the rescue and explain to begin with what it really is? And what is the Electrical Theory of Matter? We had a most illuminating article on Radio-Activity in the Journal not very long ago. Perhaps the author could step into the breach and continue the education of those of us who are so sadly behind the times.

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Table of Approximate Values of Allowances and Issues in kind.

RANK.	PAY.	FUEL.	LIGHT.	LODGING.	MEDICAL ATTEND-ANCE.	FORAGE.	SERVANTS	PENSION.	TOTAL.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Lieut.-Colonel	419 5 0	16 3 0	6 6 8	73 0 0	5 0 0	34 14 8	118 0 0	140 10 0	812 19 5
Major (of 24 years service)	328 10 0	12 15 0	2 15 9	54 15 0	5 0 0	34 14 8	118 0 0	127 0 0	683 10 5
Major (on promotion) ...	292 0 0	12 15 0	2 15 9	54 15 0	5 0 0	34 14 8	118 0 0	127 0 0	647 0 5
Captain (3 years as such and 12 years service) ...	264 12 6	6 10 6	2 0 6	41 1 3	5 0 0	34 14 8	118 0 0	127 0 0	598 19 5
Captain (on promotion) ...	246 7 6	6 10 6	2 0 6	41 1 3	5 0 0	34 14 8	118 0 0	127 0 0	580 14 5
Lieutenant	173 7 6	6 10 6	2 0 6	36 10 0	5 0 0	34 14 8	118 0 0	127 0 0	503 3 2
2nd Lieutenant	155 2 6	6 10 6	2 0 6	36 10 0	5 0 0	34 14 8	118 0 0	127 0 0	484 18 2

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THE BATTLE IN PALESTINE.

Commencing August 19th, 1918, as seen from the R.G.A. advancing in support of the Left Flank.

By Lieut.-Colonel F. P. Hutchinson, D.S.O., R.G.A.

THE final R.G.A. preparations for this battle were commenced a fortnight before the attack by filling up the forward battery positions with ammunition. This was followed a few days later by the guns themselves being put into these positions. The guns were kept quiet and practically no registration was done. Some batteries were given a shoot on hostile batteries in order to get the guns calibrated together, as owing to wear, it was necessary to redistribute the guns amongst the batteries, so as to have those batteries detailed to move forward armed with the best weapons.

During the last two days Infantry were worked across North of the Auja and hidden in Orange Groves and other cover. No fresh tents or bivouacs were allowed and all lay low during the day. Fires or movement in unusual places were avoided, and all plans kept most profoundly secret.

Nearly all the shooting in the R.G.A. barrage was in consequence done from the map. The accuracy and efficiency of the shooting under these difficult conditions proved on subsequent examination of the ground to have been very good.

At 4.30 a.m. on the 19th every gun on the front opened fire.

The tasks allotted to the Heavy Artillery were twofold. A large proportion were told off to neutralize every known enemy battery that seemed likely to be active and the remainder were turned on to trenches, strong points, and Headquarters in rear. No Heavy Artillery fire was directed on points that could be within 500 yards of our Infantry at any point of their advance. This, with the long advance contemplated, was very difficult to estimate and necessitated the fire being lifted somewhat early in the latter parts of the advance so as to ensure the Infantry not being held up by our own fire.

The R.F.A. put down their barrage, and the Infantry advance under it all commenced at 4.30 a.m.

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The 60th Division, which had just come over from the 20th Corps were on the left of the line, and with the 7th Indian, and 75th Divisions in that order from left to right, attacked the Tabsor Defences with the 3rd Indian Division on their right. The R.G.A. Brigades from left to right were the 96th (which remained and did not advance) the 102nd and 95th with the 100th on their right.

The 60th Division pushed at once for the Nahrel Falik so as to allow the cavalry to cross the Falik and make for Tul Keram, as well as mop up any enemy escaping from the line of defence, Et Tireh to the sea.

The whole attack from the right front of the 3rd Indian Division on the sea carried the first line of defence in approximately scheduled time, and the cavalry went through at the Falik and captured Tul Keram and pushed forward N. and N.E. into the 'blue'.

The 102nd Brigade R.G.A. with its Signal Section, 91st Heavy Battery (horse drawn) and 380th Siege Battery (tractor drawn) were detailed to advance as soon as the 75th Division held securely the line Et Tireh to the sea, give any assistance required by the 75th Division, and then advance to a position just east of Miskeh and there await a cavalry escort for safe conduct to Tul Keram as soon as the 60th Division sent for them.

Before the commencement of the fight, full echelon for 60-pounder (640 rounds) were put into the ammunition wagons, and full echelon for 6″ Howitzers (360 rounds) were loaded on to trucks and wagons, and in addition 60 rounds 60-pounder and 160 extra rounds for 6″ Howitzer, 3000 gals. of Petrol for tractors and oil and grease, a workshop for M.T. and the section stores for the guns. All these were near the battery ready to march off at any time after 6.30 a.m., whilst any ammunition left over after firing was left in the positions to be picked up by salvage parties.

At about 9 a.m. orders were received for the advance and the batteries at once started to the rendezvous prearranged by Brigade, behind Piffers Ridge. As there were two possible routes forward from the rendezvous, and neither could be fully reconnoitred before, two officers were sent forward on horseback, and the M.T. Officer attached to the Brigade and one other officer in a car made a hasty reconnaissance, whilst the batteries were waiting at the rendezvous to see if they would be of any use to the advancing Infantry. By 10.30 it was clear that their assistance would be unnecessary and the advance to Miskeh was ordered.

The route selected as a result of the reconnaissance was along our old front line to Brown Hill striking the Hadrah Road near the Hill, and the order of advance was as follows:—

91st Heavy Battery (horse drawn) leading, 380th Siege Battery (tractor drawn) following, and the Headquarters, which had to be retained in their Battle Headquarters until the advance to Miskeh so as to keep in touch with the Division, bringing up the rear.

The 380th Siege Battery marched off in the following order:—

(1) A Pioneer tractor with a G.S. Wagon containing spades, picks, etc., and a party of 1 Sergeant and 20 other ranks to make

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practicable all difficult places. This proved invaluable throughout, though after Miskeh it had to be utilized for other purposes.

(2) 4 Tractors each drawing a gun with a G.S. or Buck Wagon attached behind carrying 30 rounds.

(3) 2 Tractors with caterpillar trucks carrying ammunition.

(4) 2 Tractors with Trucks with Section Stores.

(5) 2 Tractors with petrol, oil and grease, carrying 3000 gallons of petrol.

(6) 2 Tractors with spare wagons and M.T. workshops.

The heavy sand along the old No Man's Land taxed the horses of the 60-pounder battery rather heavily, and they had frequent short halts before reaching the Hadrah Road, keeping back the tractors, which seemed to revel in the going. This was unavoidable and the correctness of the order of march was proved later in the day.

From the Hadrah road to Miskeh the march was uneventful except for the tractor next behind the guns slipping its track, of course in the narrowest part of the road, and delaying the rest of the column for about three quarters of an hour.

Miskeh was reached at about 2 p.m. and an attempt to water horses was made at once. The water supply was very poor at the time, and most of the horses got about half a canvas bucket of indifferent water each.

The O.C. pushed forward at once through Et Tireh to see the situation, and found fighting still in progress about three miles beyond so that the road to Tul Keram was not likely to be open for some time.

Whilst halted, the opportunity was taken by some of the officers of examining some excellently camouflaged 4·2 Howitzer positions, and a hastily abandoned Divisional H.Q. close to the halting place.

The men got a meal of tea, bully, and biscuits, and at 6 p.m. the situation had cleared up and the Liaison Officer from the 60th Division arrived after a somewhat adventurous journey with orders to proceed to Tul Keram. As some of the horses were still watering at the well about half a mile away, it was 6.30 before the column got on the move again, with what appeared to be a big margin of time to spare in order to comply with the instructions of arriving before daylight at Tul Keram.

The advance was commenced in a slightly changed order as the Pilot Tractor was put in front of the 91st Battery owing to there being a difficult Wady about half a mile from the start, and the Headquarters 102nd Bde. and Signal Section being horse drawn followed the 91st Battery, 380th Siege Battery bringing up the rear.

Trouble soon began, one of the Ammunition Tractors shed its track in the bottom of the first Wady and the remainder had to make a slight detour and cross a few yards higher up. This lame duck was repaired in about an hour and picked up the rest. Two others met with similar misfortunes immediately after and had to be left to follow on the next morning. With these were left the Workshops and some petrol.

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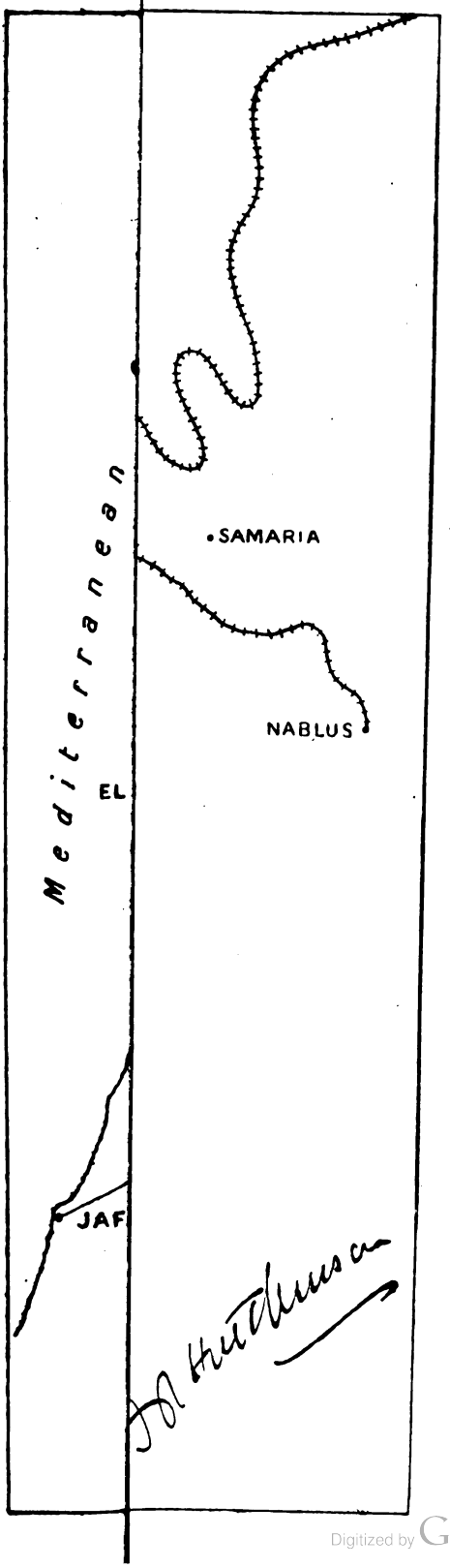

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The horses in the heavy sand and up hill were showing signs of being done up. Double teaming up the hill was resorted to and eventually a Tractor was sent to help them up.

The 91st Battery managed to get as far as Et Tireh where again they had to resort to double teaming.

At Et Tireh it became obvious that their bolt was shot, and even with double teaming it was doubtful if a section would be got to Tul Keram.

By this time the column was short of 4 Tractors, one helping up the horse transport, two with Tracks off and one with the Workshops. It was 9 p.m. when the back of the column cleared Et Tireh.

There was a very sandy narrow lane necessitating double teaming and the horses were so dead beat they could hardly get the guns through even then. It was therefore decided to readjust the Tractor loads, free the gun teams to help with the Ammunition Wagons and pull the guns behind the Howitzers, a tractor taking a gun, a howitzer and a G.S. Wagon in some cases and in one case, a Tractor pulled a Truck with 180 rounds of 6″ Ammunition and a 60-pdr. gun.

The Tractor loads varied as it was necessary to increase their loads in the manner most economical in time and even so it took till 11 p.m. before the last Tractor pulled away from the far side of the village.

Still trouble befell the column as a magneto went wrong on the rear tractor, and in the dark with workshop far away the trouble could not be traced and remedied. This again necessitated adjusting loads, and the Tractor had to be left behind. Meantime yet one more misfortune befell the struggling column as a Tractor got jammed in a cutting going into a Wady. The breakdown gang got to work at once, and hewed out a new road to one side and with this tractor abandoned also, the march onwards continued. From this point on the roads became broader and no bad Wadis were encountered so that by 3.30 a.m. 4 Howitzers, 3 60-pdrs. full echelon and 60 extra rounds of 60-pdr. and 320 rounds of 6″ Howitzer were at Tul Keram and the horses were sent off at once to water.

The last tractor which had been a bit delayed by its very heavy load of a tractor truck and a 60-pdr. gun arrived just before daybreak.

The lame ducks all got in during the day and except for workshops, which came on in the evening bringing one wagon of Headquarter stores, everything was up by 2.30 p.m. including the large stock of petrol and oil.

The breakdowns on the tractors were mainly caused by the narrowness of the Turkish roads especially in the Wadis. This caused the side of the tracks to bite and pulled them off the rollers.

The sand at various points was extremely heavy, and took all the life out of the horses.

The contract of arriving before daylight with full echelons was however completed, with the exception of 40 rounds of 6″ Howitzer, after a trek of 20 miles.

The Field Batteries had similar difficulties, and the two Heavies were the only Artillery to arrive complete.

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All the way from Et Tireh could be seen the lights of our Front Line, and near the halting place the Batteries were within 1½ miles of the Front Line, but the Turk was thoroughly demoralized and there was not the least danger of any attack from him.

On the morning of 20th, one Section of 380th Siege Battery advanced with the 179th Infantry Brigade, and the 91st Heavy Battery came into action east of Tul Keram. In the afternoon the 91st Heavy Battery and the remaining Section of the 380th Siege Battery again advanced and both batteries came into action one mile west of Anebta, the 60-pdrs. shelling the road running north from Samaria during the night at odd intervals.

The route from Tul Keram to Anebta was strewn with dead horses, mules and bullocks, and abandoned transport, consisting of lorries, motors, carts and wagons of all kinds. This was the work of the aeroplane bombing. In many places the road was completely blocked and side tracks had to be utilized to get along for stretches of a quarter of a mile or more.

On the evening of the 21st this Brigade were again to have advanced, but the work of the cavalry and infantry was so complete that the Brigade were not needed, and were turned back to their old camping ground of the night before and on the 22nd were withdrawn to Tul Keram.

The Cavalry work North was wonderful, and prisoners by thousands were sent back every day.

In Tul Keram and near it were guns, rolling stock, engines and endless booty, and all along the roads the splendid bombing work of the Flying Corps stopped the transports from getting away. Those that did, only succeeded in walking into the arms of the Cavalry who were waiting for them and thus putting the finishing touches to the Victory.

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GAUDIA CENTURIONIS

or

The Instructor of *Zeitûn*.

With acknowledgments to the Erudite Author of

"THE SUBALTERN'S JOY"

and to the Instructors of the Imperial School of Gunnery at Zeitûn, to whom this Ebullition is Gratefully Dedicated by two members of the Field Artillery Refresher Course, March 1918.

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Verses by

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NOTE.—This pamphlet is printed for Private Circulation only, is to be Treated as Confidential, and as a Flight of the Imagination based on Mathematical Facts, with an Unhistorical Setting, "to give an air of Verisimilitude to an otherwise Bold and Unconvincing Narrative," and is not to be taken into the Front Line Trenches.

FLIGHT THE FIRST.

The Poet bids his Muse depart to the War

Arise my Muse, from dreams of Khushi ease,
Palatial House and Bints and Groppi's Teas;
Let weary Mortals sit in Trains day long
But thy flight high o'er blinding sands prolong,
As on a magic Carpet sit at Ease
Or carried by the Jinn adown the breeze.

The Muse pleads for Delay

"Oh one last look at Cairo spread afar,
Her Minarets and Domes unstained by War;
Once more the Race Course hums with joyful note.
Once more my money's gone to swell the Tote.
Farewell Egg Boiler, choicest Aiming Point,
How well we know them, point by well ranged point,
For soon the Sands will lie without a break
How then to know what aiming points to take."

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A martial figure appears

But see who comes pacing across the field—
What Mars, what Hermes, neath this form concealed?
Some gallant youth, to victory addrest?
Happy the Maid who leans on such a Breast.
Even the scarlet glories of the Knuts
Have not thy Moonshine Breeches, Starshine Boots—
But Cupid blubbers "Ah he's mine no more
And Venus weeps" "My Verdans goes to War."

It is seen to be Verdans

Verdans? What cruel, what most spiteful Brutes
Have sent thee to such horrible pursuits?
Thy Home is here, with coy Geometry,
Algebra, laurel crowned, and Pedantry.
Surely sweet youth thou wast not meant for War,
Thy laboured formulae are useless there—
Where all the formulae that don't fall flat
Are "Shoot the gun off and correct from that."
Yet confidence is written in thy face—
"Now I can show that I am worth my place,
Lazy or dull they would not understand—
Now I can show the worth of what I've planned.
By careful calculation hardly sought
I'll hit my target with my earliest shot."
He fluttered in my face a Handkerchief,
"Here have I writ all gunnery lore in brief.
Day after scorching day my Chief and I
Sweated at logs and Trigonometry;
Night after Night we sat with towel swathed head,
When lights were out and all men gone to bed.
How I can test the value of that Lent
And prove our ingenuity well spent."

The Muse, unwilling, leaves for the Front

But now my Muse must take her pinioned flight
Across the wilderness, ere falls the night,
When noiseless o'er the Sand the Buddoes prowl
And Sentries shoot and Jackals answering howl;
And lighting where the Desert stretches far,
Studded with Tents and panoply of War,
Wadis with Batteries on every hand,
The guns half buried in the drifting Sand,
Seek some small tent to spread her poor Valise
And some kind Mess where cares in Beer shall cease.

Verdans arrives at the Front

The Second Day, just as we all stood to,
A draggled figure wandered from the Blue—
'Twas Verdans who had walked through half the night,
His Breeches stained, his Boots in shocking plight,

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"I could not find the Bear" he bravely said
"So Cassiopeia answered in his stead,
Trisect the top half of the double U
And then your line will pass the Pole Star through.
But if the Bear had shown his sleepy head,
I'd have produced his tail and cut it dead."
But cried the Major "Give the man a drink"
"It is, too grey an early hour to think.
There's Turks to shoot before the day is dead
And you shall do the Shoot. . Go now to Bed."
Happy he laid him down upon the Sand
And dreamed he used the formulae he planned.

Verdans is bidden to shoot Turks

So in the eve we went to the O.P.
To give the Turks a little hate for Tea:
A pleasant place enough, so sitting down.
I smoked a Pipe while Verdans prattled on—
"First we must take the angle TOB,
The range OT, the angle O to T,

He calculates the Battery Angle

Find B to O and find the Base OB.
That is the point you say, that little Mound,
Where a Machine Gun burrows in the ground—
I lay on it, the dial clamped at O,
Swing round, and read off the spot angle, so
(Take care at no time else the spot to use
Or in the Tests some marks you'll surely lose)
It's 50—What the rule for the true Base?
The distance perpendicular you trace.
More than one hundred, less than 50, Say
Take 10 per cent off for each 10 away,
My angle's 50; that's point 7 then,
That times three hundred is two hundred ten
Six times the Base in hundreds if you please,
Divide by Range in thousands—Get—Degrees.
The Battery Angle's 50, minus this—
New Range, from obtuse Angle at the Base

And the Range

Take 70; Now in front a point you place.
Then take this fraction by the shortest line
This gives the difference twixt their range and mine.

The Angle of Sight

Next angle of sight—the Radian gives it all,
Nor trust Displacement Tables, lest you fall.
Angle of Sight read from the guns to me
By BO plus the angle O to T,
Or minus, if I am above the Foe—
All over BT. There's the BOOT you know.

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But if the range OT equals BT
Or nearly, there are easier formulae.
Angle at Base on Ratio Base to Range,
Add or deduct A2—it's right though strange;
Or Apex by A1, Derees we say,
Gives minutes difference twixt A2 and A.
You work at lightning speed—A child could do it
Without the laboured figures of the BOOT.
I do e'en that, of course, all in my head,
But then I'm more than averagely well read:
For me Binomials are a rosied path,
I think, like Archimedes, in my Bath.

Concentration and Distribution

But now my guns are all laid parallel
And right along the Trench they'd give him Hell,
But I must have them all on one Emplacement
So I must find the Battery's own Displacement.
Now, one gun interval subtends 72
O'er range in thousands; All we have to do
Is concentrate by these minutes on one,
Distribute them again when all is done.
But say the Turks should suddenly appear,—
I want to get the whole procedure clear—
I shouldn't like them to go back again
Before my shells could fall on them like Rain—
If targets less than three times Battery Front
Distribute and then sweep them—That's the Stunt—
Extent of it—O'er five—For that's my Guns.
Less 72 o'er thousands—Strafes the Huns—
Now sweep—one third of target, over 5—
And we'd not leave a single Turk alive.
If target's more than three times Battery's squeeze
Switch right across—the answer's in Degrees—
Switch 72, o'er hundreds—that's the wheeze.

Nature of Projectile

So now I have some orders to give out.
Ah, here I find your lazy Gunners out;
Nature of Projectile, Cordite Mark III,
Three on fifteen, Lot 60, B.S.C.
Fuze 80, T and P, Brass, Vickers Son
And Maxim, Lot Two hundred, twenty one.
You can't take too much trouble sorting Fuzes,
Erratic bursting don't kill—only bruises.

Corrector

Now I must find Corrector of the day
And what amount of Shells to Blaze away
So that sufficient Shells may hit the Trench
And reeking Corpses send a nasty stench.
Barometer reads 29, Set Fair;

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The Fuze burns slowly in the rarer air;
A short Barometer means Corrector small,
Corrector long if Mercury is tall.
Each inch of variation high or low
Means 6 more—less, than normal 150
This makes Mean Point of Burst 10 minutes height,
To range—I want it on the Line of Sight.
Lengthen 11—7—5—4—3,
So half in Air and half on Graze, should be,
Shorten, to raise the Bursts when rangings o'er,
Bullets fall short, so make range two five more.
If one were near the target where one sees
The ideal lengths bursts short would then be these,
8—7—6—55—and then 50,
2000—3—4—5—6000—Go.
Each thousand feet you are above the Sea,
(The whole of this is in your F.A.T.)
The pressure's one inch less, so shorten six
Ere the Corrector of the day you fix.
Muzzle Velocity must be reckoned on,
Each 10 foot seconds lost, you lengthen 1.
This brings me to that variation strange.

Correction for Atmospheric Conditions

That Heat and Cold produce upon the range.
Muzzle velocity decides it all;
Calculate that, you've nearly got it all.
If Atmospheric Pressure should be low
The speed is great, the round will further go;
And if the Air is warm, and where's it not?
It further goes—And if the charge is hot
(Distinguish Cordites here from N. C. Ts)
And if the wind is with—subtract all these,
And Vice Versa, add—contrary breeze,
Cold air, Cold charge, high pressure, from the range
The Map gives—This will be the Range Drum's range.

He calculates how many shells will hit the target

Now I have done all man can do to see
That my Mean Point of Impact will be T.
You all know how erratic shooting is,
So we must deal in Probabilities.
(I told you once how Galton found it out,
Pins in a Quicunx in a Jam Jar stout),
Let's say the target's 10 yards deep by 8,
The range 4000; My range tables state
The fifty per cent Zone's 38 by 3,
Ten over thirty eight will give to me
My factor—·26, about 15
Per cent for length will fall my target in,
And so for breadth, eight over three gives two
·6, 90 per cent will do.

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15 per cent by 90 gives 13—
13 per cent is few enough, I ween.
Well, now I've Data I can go upon;
The battery angle, concentrate on 1,
Angle of Sight, Right Ranging, do you hear?
Percussion, 15 seconds, and then Fire.

So Easy!

He discovers that it is already Midnight

Wake up Telephonist, you lazy fellow,
That telephone was not designed as Pillow.
"It's after Midnight". Don't you answer me
Or you'll be run in front of the O.C.
Open the window, look, by Jove, you're right,
And I've been calculating half the night.

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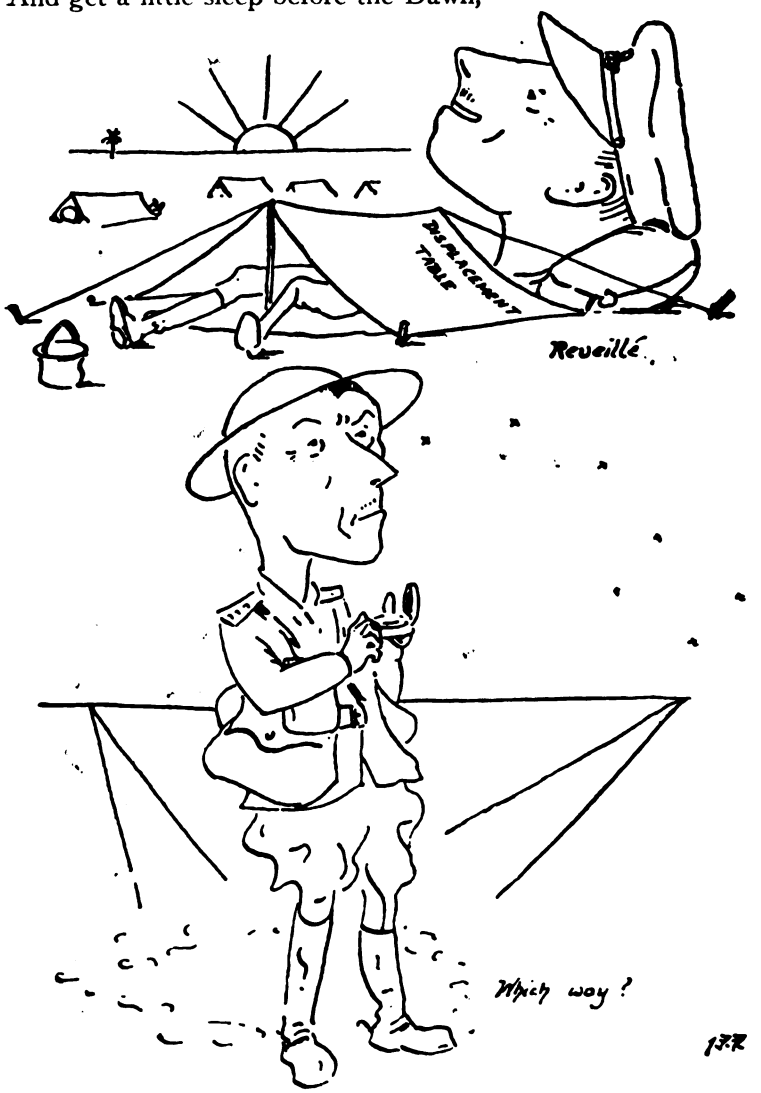
I dread to think what the B.C. will say
Finding that little Mound not blown away.
If I'd a Panorama now I'd do it—
I wish I'd had more time; I might have drew it.
But as it is I think I'd best go on
And get a little sleep before the Dawn,



I really don't know what Zeitûn would say—
Think of them falling in at break of day,
That splendid Sergeant Major, tall and staid,
Staff Sergeant Sapiens, skipping on Parade.
Even that terrible Refresher Crew,
There are some things I might have learnt from you.

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FLIGHT THE SECOND.

Verdans is asleep

Refreshing Sleep, behold our Hero stretched
In dreamful Bliss 'twixt one day and the next.
Since damp the ground was in the heavy Dew
He o'er his bed the Displacement Table drew;
Most admirable Rag, whose canvas white
Protects his Tummy from the chills of night—
While sines and tangents glitter on his breast
He wears Displacement Tables next his Chest.
And so the Evening's troubles slept away
He hears the whistle's four fold Hail to day.

He wakes at Dawn

Ere the reluctant Stars have left the West
Behold our Verdans, washed, and shaved, and dressed.
Then to the B.C's Tent he makes his way.
"What are my duties this Sunshiny day?"
The Major cursed—"Why mayn't I sleep at nights?
You go to—Well, go and test the Sights."

* * *

He shews the Major how best to do an aeroplane shoot

The Sights are tested, breakfasts eaten, when
A wire from C.R.A. arrives—"At 10
An Aeroplane will do a Shoot with you—"
Stir and activity reign the Battery through.
One runs to fetch the Ground Strips—These were white—
And others set the Wireless Masts upright.
The Major gets his Gadgetts, paper, copper,
Cries Verdans "Nay, a Gadgett's most improper.
Look at your Watches, Gentlemen, and see—
My Tables do the whole thing beautifully—
Follow me close, your Gadgetts fling away,
You'll never want them more after this day.
Each hour upon the Clock's 30 degrees
So set your Watches to the Bearing please.
True Bearing BT is 270
IX at the top, XII on the right will go.
I will not show you now the how and why,
I might explain it till the Nile ran dry.
Cadets and Officers have seen me stand
Talking for hours, and would not understand,
But if someone is really interested,
Please come and see me after, when we've rested.
Now take the Displacement Table which I brought you,
The use of which so carefully I've taught you.
The included angles represent the Bearing.

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X's 30-XI 60, the Watch declaring
Whether the shot observed fell left or right,
While IX and III are on the Line of Sight.
Next take the Circles A, B, C, D, E.

With the Displacement table

Divide into the range—this gives to me
The Ratio on the top side of the table;
With this and the Clock angle, you are able
To read the Apex angle. That's your switch.
Then take the nearest number in brackets, which
Times hundreds in the circles, A,B,C,
The range correction quickly gives to me.
Its accurate, Gentlemen, and what's more it's easy
And is there any Gunner who's so crazy
As after this to use some curious Gadgett—
He'll surely break his Egg ere he can hatch it.
I'll show you something else, the while you strain
To calculate the range to the Aeroplane,
While the faint Wireless "Esses Beer" is calling—
It's all worked out before it's finished falling.
At the right hand top corner of my sheet
You'll see two Scales, top yards—the right edge feet.
You hang a plumb line from the Observer's height
On the right hand scale, and fix the Table tight
On your Director; following up you lay
Upon the Smoke Bomb in the usual way,
Then where the plumb line cuts the lower scale
You have the range to target—It can't fail.

The Officers go back to the Mess

The Officers stood round with open mouth
Mazed with the learning of the ingenious youth,
The white plane circled in the cloudless Heaven
Like some hugh Sea Bird. It was just eleven,
When came a message from Brigade H.Q.
"The shoot's a wash-out, for we can't get through."
With Homeward pointed nose the white plane sank—
We to the Mess, and opened Beer, and drank.
"Gun Drill's at 12," the Major looked at me,
(I'am usually R.O.) "And we will see
How Verdans shapes at your job; doubtless you
From him may learn a cunning trick or two.

I am ordered to go with Verdans and give a Line of Fire with a Compass

Both of you do it with Compass and Director
And we shall see which of you's the Correcter.
The Magnetic Bearing is 279,
Go to the rear and give each gun its line.'

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Verdans shows me how to do it

Kind Verdans, he was very good to me,
He did it first, and slow, so I could see.
"Hour after hour," he said, "I've talked of this
In that old shed at Heliopolis.
The denseness of my hearers made me weep,
I used to dream about it in my sleep.
Set arrow to the angle, left or right
Of North—turn till the Compass needle's pointing right,
Clamp, swing the plate to Zero—All you need
Is Lay on each gun's Dial Sight and read
The spot angle, right or left—you give it out.
4 doubles up if it's too far to shout,
They set the Sights and lay on the Director.
The lines are parallel—nought can be Correcter."
"But if you use a Compass, how do you act?"
"Take bearing to each gun in turn, subtract
This bearing from the one your target's on.
Result from one eighty's the angle for each gun.
Look towards the target—if gun's on your right
It's right deflection they put on the Sight.
If the gun's left, give Left. Now is that clear?
The rule applies whether you're front or rear."
So Verdans helped me like an elder Brother,
And we got the same angles one as t'other.

The Major prepares a hard test for Verdans

That evening when the Sun had grown less hot
We all went mounted to a distant spot.
The Major still thought Verdans might be caught
And for some wily test to give him sought,
And jealously we longed to see him quail,
To see that confident face of his grow pale.
We realized some cunning plot was brewing,
That very place had often been our ruin.
He spoke, "See that O.P. behind the Sap,
Now Verdans, find this place upon the Map,
And get the Battery on and strafe that Tower.
Battery action is in half an hour."
We shivered—could there be a harder test?

Verdans resects his position

But Verdans didn't seem a bit distressed.
He chose three points on the Map—often we'd seen them,
He measured carefully the space between them,
A B, B C, took Bearings to all three,
Then turning to us said "Attend to me.
I've now got all the needed information;
After I've done a little calculation

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I'll resect accurately our position—"
We shuddered at his wondrous erudition.
I want to find a circle that will be
Through A and B and this place. Divide A B
By twice the sine of the angle it subtends
And you've the radius of the circle, friends.
With this as radius, centres A and B
Describe two Arcs which intersect at D.
D's centre of the circle that we want,
BC the same; where they cut is our point.

We are seen by the Turk who opens fire with 5·9 shells

Just then we heard a sound like a train's roar
Or like a great Wave breaking on the shore
Of Blighty, and a Crump—It was a plus
And evidently it was meant for us.
And then close to the Tower we saw a flash
And dust—and afterwards a crash
In front of us—they'd got their bracket now,
And each of us instinctively crouched low,
When the next rushing shell-express came o'er;
The Major grew intent expecting more.

Verdans ranges on the hostile gun

But Verdans begged him, "Trust the shoot to me.
I'm good at ranging on the line O.T.
I've got the Apex angle even now—
No. 1 ranging, 3500, so—
That shot fell three degrees left the Line O.T.
I calculate how much short that will be,
Solve the small triangle and fire again—
Repeat—so making sure that I obtain
The right correction—Now that round fell plus
I drop 100 and I switch across,
Tan Alpha by a hundred gives the switch
In yards; bring to degrees or minutes, which
Is easy; Minus—if it's not, repeat.
Add fifty, switch by half the angle—neat,
And true I've hit it—As we watched the gun
Verdans snapped orders down the Telephone

With marvellous success

And as we looked sudden there leaped a wall
Of smoke about the target and a pall
Of dark smoke hung and slowly died away.
No more Five Nines came troubling us that day,

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He vanishes from our sight. We see that he must be more than mortal

But when we turned to praise him for his shoot
He was gone, not leaving any print of foot,
And though we searched and wandered to and fro,
Up hill and down hill, looking high and low,
We found him not—and all that we were able
To find, was a much thumbed Displacement Table.

L'ENVOI

"Now that we've done our best and worst, and parted",
And we are going up the line again,
Accept this greeting from the grateful-hearted,
Because we have not come to you in vain.

Judge not by marks the value of your teaching,
The first rough crop the desert sand has known:
Day after day, the waters further reaching,
The desert slowly yields her to the sown.

And yet perhaps, we're not too sad it's ending.
(If I may say so without being rude),
And you from teaching rest, we from attending—
"I have need to busy my heart with quietude."

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THE EMPLOYMENT OF OFFICERS IN TOPOGRAPHICAL SURVEYING.

BY MAJOR R. H. ROWE, D.S.O., M.C., R.G.A.

NOW that peace is within sight, it is probable that the settlement of boundaries and the revival of colonial and commercial activities will lead to a revival of survey work. There are many officers who would be glad to take part in such work if they knew how to set about it. Before the war it was difficult to obtain men with the requisite technical knowledge and presumably the difficulty will not have decreased.

It is to be remembered that Topographical Surveying is practically unknown in England, except as part of military instruction, and it will be found that the majority of surveyors employed in outlying parts of the Empire are either soldiers or men hailing from the Dominions, where the development of new lands calls for original topographical effort.

What are the technical qualifications expected in officers taking up topographical surveying? It is proposed to describe briefly the processes necessary to the production of a topographical map and, finally, to deduce from this summary a list of the attainments a candidate for such work should have acquired.

Surveying, generally speaking, divides itself into five classes:

(a) *Geodetic Surveys.* To determine the shape of the earth.
(b) *Topographical Surveys.* The construction of the map of a country.
(c) *Cadastral Surveys.* Town plans.
(d) *Revenue Surveys.* For assessment of taxes and revenue charges, etc.
(e) *Special Surveys*, e.g. for roads or railways.

It is proposed to discuss here (b) only, though that must not be taken to indicate that other kinds of surveying are not of great importance or that officers cannot be usefully employed on such work.

Broadly speaking, topographical work in the field divides itself into the following sections:

1. Triangulation.
2. Astronomical and theodolite traverse work.
3. Plane tabling and other methods of putting in detail.

No regular survey takes place unless based on a rigid triangulation, and without such framework no survey can be considered as other than "exploration", or a temporary expedient to meet urgent necessities pending more deliberate work. This triangulation is conducted with considerable accuracy by means of measurement of the angles of triangles with a theodolite, and the

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results computed mathematically and adjusted for certain errors and the shape of the earth. It starts from a "base" which is measured with great exactitude.

By this means a large number of points are carefully determined over the whole area to be surveyed and form a "frame-work" on which the minor detail of the map is "hung" or plotted.

Astronomical methods and theodolite traverse work are used to supplement the triangulation in "bush" or forest country where long sights are often unobtainable and where it is therefore impossible to lay out the triangles described above.

Astronomical work, although very interesting and possessing a peculiar attraction for those who wish to become surveyors, must be regarded, with certain exceptions, as a useful auxiliary of doubtful accuracy to be employed only where triangulation is prevented by exceptional conditions.

Generally astronomical work is undertaken as follows:—

(a) The determination of latitude by observation of north and south stars, at highest altitude or *circum meridian.*

(b) The determination of longitude by telegraphic differences in time or by transportation of chronometers.

(c) The determination of longitude by "occultations".

(d) The determination of azimuth or the true bearing of a given line.

It may be said that methods (a), (b) and (c) should never be used when triangulation is possible and that transportation of chronometers, a favourite with "explorers", is too inaccurate for serious work. One of the chief reasons for inaccuracy in determining latitude astronomically is that the pull of gravity is not always exactly vertical.

Method (d), the determination of azimuth, is a very useful process that is constantly required for all purposes.

The third section of topographical surveying is the plane tabling, or other method of putting in detail. Now it would be obviously impossible to survey, with the mathematical accuracy which is employed on the triangulation, every little path and village over the thousands of square miles to be delineated, nor, for reasons which will appear, is this necessary. The primary requirement of a good topographical map is its frame-work, always formed by triangulation, except when natural difficulties necessitate recourse to theodolite traverses and astronomical determinations. This framework, as has been previously mentioned, provides a great number of accurately fixed points over the whole area to be surveyed. The "detail" surveyor, moving with his plane table between these fixed points of the framework, determines his position repeatedly from them by resection, and interpolates the intervening detail by measurement, using a measuring wheel, steel band, pacing or intersection according to which is suitable, observing the principle that no method used by him is such as would produce an error in the map on the scale on which he is working.

The object of the framework will now be apparent. Although the detail on the map may show no error at any given point by the methods adopted, the accumulation of infinitesimal errors over a

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large area would be very considerable. The detail, however, is hung or plotted on the exact framework, so accumulation of these invisible errors into a sensible error in the map is entirely avoided.

Subsequently, in the making of a topographical map, the processes of reproduction and the arrangement of records have to be dealt with.

Survey work on a boundary commission is often very similar to regular topographical survey work and sometimes takes place in conjunction with a regular survey. It may, however, involve expedients that would not be admissible in regular work.

Having briefly summarized the nature of the work required to carry out a topographical survey, we may now attempt to state the qualifications required of an officer who desires to take part in such work, or the work of a boundary commission.

(a) He should be a fair draughtsman or at least neat and painstaking, with an "eye for country".

(b) He should have a good sound knowledge of plane tabling, including heights and "contouring".

An officer with the above qualifications might be usefully employed on the "detail" of a topographical map, under supervision. To be really useful, however, he should be able to carry out the following:

(c) Use a theodolite in triangulation, theodolite traverse work and the determination of azimuth.

(d) Be able to compute topographical triangulation, astronomical azimuths, theodolite traverse co-ordinates, geographical and rectangular co-ordinates.

(e) Have a good general knowledge of the principles of topographical surveying as set forth in Close's Text Book.*

The computations mentioned in (d) are not difficult but involve the use of logarithmic tables and a knowledge of elementary mathematics. The computations are worked out on set forms which simplify matters for the average man, ensure regularity of procedure and prevent mistakes (see examples in Close's Text Book of Topographical Surveying).

A course of instruction at the Royal Geographical Society, or at the Ordnance Survey, is the best way of acquiring a knowledge of the use of the theodolite.

There are many other subjects that might be brought forward as part of the training requisite to make a good surveyor, such as the running of levels, determination of latitude and time, stadia work, etc., but I have confined myself to stating as simply as possible the elementary subjects in which an officer should be qualified to make himself immediately useful to a topographical survey or on a boundary commission.

It is, of course, an immense subject and, if he has aptitude and liking for the work, he will find that the interest increases as he progresses and that a great field of enterprise reaching to every quarter of the globe is open to him.

* "Text Book of Topographical and Geographical Surveying"; by Colonel Sir C. F. Close, K.B.E., C.B., C.M.G., R.E. Wyman & Sons, Ltd., 1913. Price 7/6.

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"A TOUGH LOT."

BY MAJOR GENERAL J. B. RICHARDSON, Col. Comdt., R.A.

I WONDER if there are many of the young officers, who are joining the Royal Artillery in such numbers, who are as anxious to do all that is correct, and to carry on the ancient traditions of the Corps, as I was when I joined some 67 years ago? There were only 2,453 officers, who had ever served in the R.A., before me. We all knew the reputation of each one who was then serving and we were generally a happy family. Now the family may be counted in tens of thousands and we can know but little of each other.

As a cadet I became a hero worshipper of some of the old R.A. Officers whose actions, during the Peninsular and Waterloo campaigns, were often talked of in the Cadet Company. Many were then living amongst us. Men, such as Dickson, Sir Hew Ross, Norman Ramsay, Congreve, Shrapnel, Fraser, Bull, etc. were household words with some of us and of these Norman Ramsay and Sir Hew Ross appealed to me forcibly, the former because he was so infamously treated, and the latter for his many wounds. Sir Hew was then our Adjutant General.

During one of the holidays I was staying in Lincolnshire with an uncle, the Vicar of a very large fen parish. He sometimes invited me to go with him on one of his frequent visits to his parishioners. One day we called at a cottage on the "Hiddicks" (Eaudykes) where an old Peninsular and Waterloo soldier was lying ill. I was duly introduced to the old infantryman as a cadet of the Royal Artillery. "Ah! said the Veteran" A tough lot, a very tough lot them Artillery. "I mind me one day before Badajos we were in line waiting, when "right across our front came an artillery officer, a-galloping like "anything, with his head under his arm all covered with blood. But "he never felled off, and whatever became of him I don't know. "They called him Eu Ross or summut of that sort and t'was said "they got his head on again. Did you ever know of him?"

I was able to assure him that Sir Hew Ross was still alive, but he merely repeated "They're a very tough lot they artillery, very tough".

This anecdote of one of my heroes led me, when I got back to the Academy, to look up Sir Hew's services in Hart, I found that he had been severely wounded in the head at Badajos and there was therefore some foundation for the old soldier's story of what he had seen. I, of course, had no premonition of how seriously my future career would be affected for the worse by my artillery hero's action in his old age. I might not have loved him so much.

Early in 1855, when I was just 17 years old and the Crimean War was in progress, I was gazetted a Lieutenant, one of the first to enter the Regiment in that rank. After a brief period of leave at home I was ordered to join at Woolwich, then the H.Q. of the

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R.A. all over the world. It was a hot bed of officialdom. The Adjutant General, the C.O's of some 10 or 11 Brigades of Artillery, and as many Adjutants flourished there. The latter were more or less considered by the younger officers as their natural enemies who, like Masters at schools, it was as well to avoid as much as possible. They had very little to do, for there were very few troops and batteries at H.Q. for them to play with, so they mostly occupied themselves with the hunting and worrying, no doubt for their good, of such young officers of their battalion as they could lay their hands on. The front parade of the R.A. Barracks was divided, longitudinally in half, by a shallow rain gutter and the unpopular Adjutants were known to their young victims as the 'Gutter Jumpers'. Their sole feats of 'derring-do' on the morning parade being said to consist in jumping their horses over this drain. When warned to join at Woolwich I was told to report myself to the Adjutant 5th Battalion. I did so, and he gave me a quarter at the East end of the long front. He also told off a soldier servant with 5 or 6 good conduct stripes. These old soldiers were known as 'Dry Nurses'. What they did not know of Woolwich ways; what young officers had to do; and how to extract petty sums from their masters' pockets was not worth studying. They were however careful of the young officers' rights in the matter of coals, candles and barrack damages. My quarters were bare, except for a table, four windsor chairs, a coal scuttle, fender, and fire irons and looked amazingly uncomfortable even after an Academy barrack room, desolate in fact. The servant unpacked and arranged my travelling furniture, chest of drawers, washing stand, tub, and bed but the room still seemed cheerless.

'Now', said the Dry nurse, 'I'll go and draw your coals and 'candles. But I will tell you what more I can do Sir. If you let me 'have a sovereign I can let you have some brass candlesticks, a good 'bit of carpet, and some shoe brushes which Lieut. X made me a 'present of when he went to the Crimea a week or two ago. I can 'also buy pipeclay, blacking, matches, etc. Your regimentals will be 'put out for Mess and I will see that everything is all right, though 'I hardly understand all this new uniform.'

I thanked my benefactor, gave him the sovereign, proceeded to explore my surroundings, and presently found two or three of my own batch of last joined officers. Their experiences tallied with mine.

Just before I joined a considerable change had been made in the R.A. uniform and we were the first batch to join in Tunic and Busbies. As cadets at the Arsenal we had worn the handsome coatee and epaulettes. The Tunic did not seem smart to us. We thought it plain and babyish. The older officers seemed to stare at us and not to approve. There was no mess dress, we dined in full dress. My adjutant had duly instructed me that it was not etiquette to leave the table after dinner until the first cannon had gone round, and the Queen's health had been drunk. I remember I was glad to get away as early as possible. I was in orders to go and see the Adjutant General at 11 a.m. next day. His office was entered under the pillars nearest to the West end of the front. Duly arrayed and brushed up by my servant I marched along the Barrack front, trailing my sword, and proudly returning the salutes of the R.H. & R.A.

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sentries at the centre arch until I entered the sacred precincts of the Adjutant General. From a printed board on the wall I gathered that he lived upstairs. Accordingly I dashed up, my sword making a great clatter on the stairs. Before reaching the top a Staff Officer appeared holding up his hand in horror.

"Please do not make such a noise, Sir Hew cannot *bear* such disturbance". He spoke as if I were a child. I caught up my sword.

"Please go into the waiting room. When Sir Hew sends for "you do not say too much. Sir Hew does not like much talk and he "is not very well."

After a long wait I was called for—and carefully grasping my sword and removing my busby I crossed the passage and entered a very much darkened room. There, behind a large table desk, probably "Desk Table, Mark I," sat the Hero I had long worshiped.

He hardly came up to my expectation. As he sat rather huddled up he seemed a little old man. I do not think he once glanced at me during the interview, but, after an interval he looked at the Staff Officer and ejaculated in a grumpy voice:—

"Umph! What's this?"

"A Last joined Officer Sir."

"Umph! What's he want?".

So I said "Please Sir may I go to the Crimea?".

Sir Hew again turned to the S.O. "Umph! Does he subscribe to the Marriage Society?".

Now I had not the faintest idea what the Marriage Society was, I looked at the S.O. in a perplexed sort of way in hopes he would give me a tip by a nod of the head or a shake. He appeared perfectly unconcerned and I was reduced to a seventeen year old judgement as to what answer I had better give. I rapidly ran over in my mind whether it was best to say 'Yes' or 'No', came to the conclusion that his question had something to do with being married, and that Sir Hew Ross might consider that a married man would be less likely to be sent to the War than a bachelor so I answered quite cheerfully "Oh! No Sir". That did it. Sir Hew promptly said in a very gruff voice "Umph! *West Indies*".

I saw almost at once what a mistake I had made though I was not certain what had offended the great man. On enquiry outside I learnt that endeavours were being made by the authorities of the Regiment to found the excellent society that now exists for providing pensions for R.A. widows, and pressure was being put on young officers to subscribe in the unmarried class. If I had been told to I should have been quite willing to subscribe. Knowing nothing of this my answer was a toss up. I lost, and to the West Indies I went for nearly five years thereby losing all chance of active service in the Crimea and Mutiny. I acquired a strong belief that distinguished officers had better retire before getting too old for useful work, but I still hold that Sir Hew Ross was one of our greatest Artillery Heroes—in his day—and that I was a young fool not to have said 'yes'. It has been 'Quo fas' and not 'Gloria' in my case but I have had the pleasantest of lives in the Royal Regiment in spite of my initial mistake

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ARTILLERY PACK SADDLERY.

BY CAPT. (ACTG. MAJOR) F. C. A. TROUP, R.G.A.

A few practical notes on the fitting and adjusting of the ordnance pack saddle may be of interest to officers of pack artillery who have not served for any great length of time with that branch of the Regiment. The difficulties suggested by the writer may have occurred to many and the methods put forward for competing with them may raise points of interest which possibly might not have otherwise occurred to officers new to the job. These notes are based mainly on F.A.T. (1914) para 93, and will serve their purpose if they draw the attention of officers to the principles laid down therein.

The efficiency of pack artillery, as that of wheeled artillery, is dependent on the mobility of the unit and therefore the question of the fitting of the harness of every individual animal is all important under conditions where it is required to maintain heavy and cumbersome top loads on a mule's back through a veritable fever chart of incline punctuated with jerks and minor bumps, or to trot animals so laden for even the shortest distances, it is evident that only a careful appreciation of the artificial aids at one's disposal will save the animal from damage and enable the unit to go on marching.

In pack artillery there can be no question of scrapping loads, nor have we wagons to help us out, and the section officer does not take long to find out that ten per cent of casualties (under normal establishments) runs his command perilously near to immobility. It is with a view towards helping him to avoid this undesirable result that these notes have been written.

Successful harness fitting depends on (a) forethought: or attention to the saddle and its accessories before marching (b) observation both at the preliminary inspection and on the line of march (c) experience which is gained by noting results when the march is completed.

The fitting of the pack saddle is laid down in F.A.T. (1914) 93 subsection No. 1 which ordains that "the saddle should be placed in the middle of the mule's back so as to interfere as little as possible with its free action". Experience shows that this is sometimes taken to mean in practice "Anywhere on the mules back". This is not good enough. The ordinary practical rule is to fix the limits as one hand's breadth behind the play of the shoulder and one hand's breadth clear of the hip. In practice however, the ordinary mule is too short in the back or the pannels themselves are too long to satisfy the above requirements, in which case it is safer to err rather

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rearwards than forwards, and to put the saddle further back. In any case galls on the loins are rare as compared with wither galls for the reason that nature protects the former part better than the latter. "The two pannels should contain the same amount of stuffing". When in doubt, weigh them: there is a very excellent article provided in pack saddlery equipments which will come in useful for this.

"Elasticity" is rather a rock in the novice's path. A soft pannel collapses, a hard pannel rubs the mule, but better, a hard pannel or rather, a hard pair of pannels. The blanket will help towards shape at least, and probably towards elasticity as well, and a good blanket, well folded, covers a multitude of sins. In any case once a pannel is shaped to the mule, leave it alone: ceteris paribus a pannel which rebounds when beaten with a stick or pressed with the hand will take its shape when the weight is on it.

The question of the pannels taking "an even bearing" is a broad one. It very often happens that sufficient atttention is not paid to the relation between the pannel patches, sidebars, and the cheepstraps, or thongs, securing the same. These, in combination, form a very useful adjusting device, the pannel being raised by attaching the sidebars low down with the cheepstrap through the lowest hole of the patch, or being depressed by the inverse process. A combination of the two, however, in the same ordnance saddle is usually disastrous, at any rate, on a long trek, as it leads exactly to the evil we wish to avoid, namely, an uneven bearing. The section officer must rub in to his driver ranks that irregular positions of the pannel patches with reference to the sidebars of a saddle are or ought to be anathema, and secondly, that the pannels should be attached to the sidebars and stays connecting bottom so tightly as to allow no play. The even bearing on the sides throughout is frequently overlooked. If the saddle fails to touch the mule evenly everywhere the saddle does not fit. Probably a minor readjustment of the stuffing, by teasing, will suffice, if not, a little judicious springing of the front or rear arches (with a heel rope, please, not a hammer) may do the job. Overdoing this springing may weaken the arches, and the section officer would be well advised to supervise the process until, at any rate, he is confident that his subordinates' cheerful enthusiasm for this pleasing form of manual labour is not likely to carry them away. Brute force and sheer ignorance will probably make matters worse than they were before.

The channel is all important. A good tip is to stitch down the serge lining of the pannel three inches or so from the top in a straight line (not a curve). Without this the stuffing works up from the parts under friction to the top edge of the pannel, which does no work at all thus denuding the bearing surfaces of protection and tending to wither-gall the animal by lessening the distance between the pannels in front (the three fiingers of F.A.T.) Eliminate the unnecessary part of the pannel, by stitching down towards the line where pressure comes and you will find that the pannel remains consistently firm on its top surface throughout. Besides keeping the channel at an invariable width this causes the saddle to gain

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considerably in appearance. The exact degree of width (say three fingers, or better one hand in front) can be gained either by springing the front arch within reason, or by varying the height of the stitching down, or by varying the amount of stuffing, but individual cases will require their own treatment, and the above can only be, a rough guide.

The saddle can be made to ride low by adjustments of the pannels by the above mentioned methods or a combination of them and also by moving up the pannel patches to the top of the pannel. The shape of the ordinary cradle is such that the channel forms automatically in rear and there is much less chance of damage occurring from a fault there. In the writers experience a hand to a hand and a half in rear is usually obtained. A narrow channel behind would cause sore sides but the appearance of the saddle ought to give the defect away before any serious damage is incurred.

As regards the blanket. It is just as well to sacrifice appearance to efficiency and pull the blanket right up in front so that one hand can be inserted between it and the withers. The lower line of the blanket will thereby become slightly inclined to the lower edge of the pannel but the measure is worth trying and has been known to give good results.

Girths in pack artillery are the despair of the section officer new to the job. Loose girths mean galls and tight girths not watched mean worse galls. With mules unused to the strain, overtight girths lead to serious swellings fore and aft of the seat of girth which often kill the tissue and render the use of the knife necessary, thus incapacitating the animal often for as much as two or three months.

To follow the sequence of this section of F.A.T.

(A) Crossing. It is well to remember that girths are crossed first near front to off rear and then near rear to off front.

(B) Tightness. It is suggested with reference to the tightness of girths that a good rule is that they should be tight enough to allow one finger to be inserted with difficulty between them and the mules body when the load is on. At any rate, in extenuation of this departure from the letter of the law there is the argument that loose girths will be pretty certain to gall whereas tight girths will only cause swellings if the driver omits to loosen them when the load is off for a decent while, in other words if the driver neglects his job. Provided the ordinary rules are adhered to as regards loosening of girths gradually after work, and vigorous hand-rubbing in stables when they are finally cast off, tight girths as defined above should let nobody down. Moreover that cheerful and intelligent animal, the mule will probably give very clear indication as to when the girth business is being overdone.

As regards subsection 3 "the breast piece and breeching", there is a tendency towards allowing them merely to hang from their supporting straps, and leaving it at that. Even on the flat, these pieces play their part in keeping the saddle in its place and should therefore be reasonably tight always. Bad crupper adjustments give trouble on the flat, let alone the hillside in many instances because

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the relation between the crupper and the breeching is not appreciated. When crupper galls come in epidemic form, as they sometimes do, tighten up breechings and aim at breeching galls: it will be found that the number of crupper rubs will decline in inverse ratio to the mule's loss of hair from the effects of the breeching. It is no uncommon thing to see a mule padding down hill with his dock vertical and an overtight crupper slipping up his tail, all due of course to a loose breeching. Loose cruppers on the other hand are certain to rub on the hill side and help towards wither galls by letting the saddle work forward. Nine times out of ten the crupper is soft enough. Many a driver in stables afterwards disclaims responsibility for a crupper rub and produces a soft crupper as evidence with an injured air; the truth is that the error is probably one of adjustment. A crupper cannot be made soft enough to be fool proof.

Above all one must add the axiom that the same saddle must invariably go on the same mule. "Casualty relief" mules therefore should be picked for shape with a view to their taking on another's gun saddle with the least possible risk of injury to themselves.

Results can only be obtained by taking pains, but it is worth while if the section officer can report "No casualties" at the end of a long day and whenever he can score a possible of such reports after continuous trekking he can flatter himself that his job of work has been well done.

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THE RAPID CALCULATION OF SWITCHES FROM AN O.P. WITHOUT A MAP.

BY MAJOR S. R. NORMAND, D.S.O., R.G.A.

THE extent to which semi-open and open fighting had emerged last summer and autumn demands that more attention be given to the indication of targets without the use of maps.

Close and efficient support of the advancing Infantry will frequently require a change of position, and rapid opening of fire, to which "deliberate" methods are quite unsuitable.

The lines of fire must be laid out by the most expeditious manner possible, and switches to other targets can only be obtained by calculation. There is no "prepared" map, nor has there been opportunity for studying the front.

Accuracy may not be sacrificed to speed except to a very limited extent, for the shell bursts of other batteries engaging targets in the vicinity, will absolutely prevent recognition of the rounds of one's own battery unless they fall close to the target.

Where the F.O.O., is in or near the line B.T., the rapid calculation of switches presents little difficulty but where the O.P. is to a flank, constant practice in whatever method is adopted is necessary for accurate and rapid results.

These two cases are treated separately under A and B.

A. When the O.P., is in or near the line B.T.

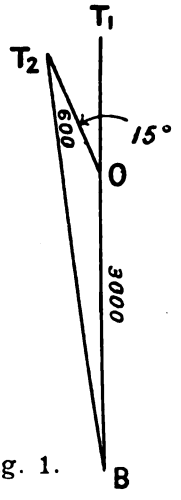

Fig. 1.

Suppose the Battery at B is engaging a Target T_1, and has to open fire rapidly on T_2.

The angle T_2BO may be calculated as follows: The F.O.O. multiplies the exterior angle at O by the ratio $\frac{OT_2}{OT_2 + BO}$

i.e., $\frac{1}{6}$ and gives the result 2° 30′ M L to the Battery as a switch.

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B. When the O.P. is to a flank.

In this case the switch angle bears no direct relation in amount, and may even be opposite in direction to that observed at the O.P.

The required switch may be obtained by the following methods:

(1) By use of Field Plotter.

(2) By partly solving the triangle with slide rule, or by means of suitable formulæ.

(3) By application of the method given in "A" above.

Method (1) Is cumbersome and inaccurate.

(2) Is the most accurate for all cases, and with practice is as rapid as method (3).

(3) Is suitable for small exterior angles, but becomes more and more inaccurate as the exterior angle becomes greater, and is unsuitable when the exterior angle exceeds 30°, i.e., when the angle TOB is less than 150°.

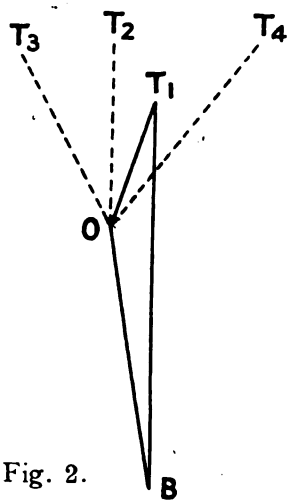

Fig. 2.

Suppose the Battery having come into action at B is engaging a Target T_1. The guns have been laid in the line of fire without the use of a map.

The F.O.O. is at O (Figure 2.)

Suppose $T_1\hat{O}B = 165°$

$O\ B = 3150^{\text{x}}$

$O\ T_1 = 600^{\text{x}}$

Then $O\ \hat{T}_1B = 12° 37'$

$T_1\hat{B}\ O = 2° 23'\ R$

$B\ T = 3740^{\text{x}}$

Suppose now F.O.O. has to engage targets at T_2, T_3, T_4.

The switch angles to the various targets may be given to the battery either as—

(a) an angle R or L of T_1 (Zero)

or (b) a switch from whichever target was previously engaged.

If the latter the F.O.O. should calculate it from (a) as by this method the angle at B remains constant. Case (a) only need be considered as case (b) is merely an extension thereof).

We have to find the angles—

(a) $T_1B\ T_2$

(b) $T_1B\ T_3$

(c) $T_1B\ T_4$

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The following *Rule* is an assistance "Change the sign (i.e., direction) of the original angle" "O B T_1 and add to it the new angle at B (i.e., O $\hat{B}$ T_2, O $\hat{B}$ T_3, O $\hat{B}$ T_4) R or L according to usual rules.

Examples.

(a) *Target* T_2 is observed at O as 8° L of T_1 at a range of 700ˣ
The original angle at B was 2° 23′ R
Write this as 2° 23′ L (according to "Rule" above)
Exterior angle is 7°

$$\therefore T_2B\ O = \frac{700}{3150 + 700} \times 7^\circ$$
$$= 1^\circ\ 20'\ R$$

Hence switch from T_1 (Zero) is 2° 23′ L + 1° 20′ R or 1° 3′ L

(b) *Target* T_3 is observed 25° L of T_1 at a range of 800ˣ
Exterior angle is 10°

$$\therefore T_3B\ O = \frac{800}{3150 + 800} \times 10^\circ$$
$$= 2^\circ\ L$$

Hence switch line from T_1 (Zero) is 2° 23′ L + 2° L
= 4° 23′ L

(c) *Target* T_4 is observed 10° Rof T_1 at a range of 900ˣ
Exterior angle is 25°

$$\therefore T_4B\ O = \frac{900}{3150 + 900} \times 25^\circ$$
$$= 5^\circ\ 30'\ R$$

Hence switch from T_1 (Zero) is 2° 23′ L + 5° 30′ R or 3° 7′ R

NOTE.—Calculated by slide rule, and using the "tangent method" the angles at B are found to be as follows:—

$T_2B\ O = 1^\circ\ 16'$
$T_3B\ O = 2^\circ\ 2'$
$T_4B\ O = 5^\circ\ 28'$

showing a difference of only two or three minutes from those found by applying the ratio $\frac{OT}{OT + OB}$ to the exterior angle as in A above.

Where the exterior angle to TOB is greater than 30° the formula given in A is liable to introduce too large an error, and it is preferable, if time permits, to solve the TOB triangle by the slide rule using either the tan or the sine method.

Suppose a Battery, having come into action at B is engaging a Target T_1. F.O.O. is at O (Figure 3.).

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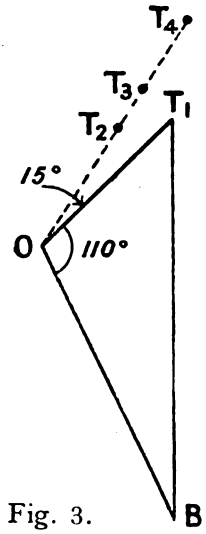

Fig. 3.

The guns have been laid in the line of fire B T_1, without the use of a map

$T_1\hat{O}\ B = 110°$

$O\ B = 3220^{\text{x}}$

$OT_1 = 660^{\text{x}}$

The exterior angle at O is therefore 70° and Battery angle $T_1B\ O$ is given as 10° 12′ R.

Suppose now F.O.O. has to engage targets at T_2, T_3, and T_4, all 15° L and at ranges 550^{x}, 850^{x} and 1500^{x}, respectively from O. (The same angular switch is taken in order to show how the value of the Battery switch depends on the range OT).

Using Method B (3).

Target T_2 is observed 15° L of T_1 at a range of 550^{x}

Exterior angle is 55°

$$\therefore\ T_2\hat{B}\ O \text{ is } \frac{550}{3220 + 550} \times 55°$$

$$= 8° 18' \text{ R (by method B (2) } 7° 15' \text{ R)}$$

Writing the original angle $T_1B\ O$ (10° 12′ R) as 10° 12′ L

Then switch from T_1 = 10° 12′ L + 8° 18′ R

= 1° 54′ L

Target T_3 is observed 15° L of T_1 at a range of 850^{x}

Exterior angle is 55°

$$\therefore\ T_3\hat{B}\ O \text{ is } \frac{850}{3220 + 850} \times 55°$$

$$= 11° 30' \text{ R (by method B (2) } 10° 38' \text{ R)}$$

Then switch from T_1 = 10° 12′ L + 11° 30′ R

= 1° 18′ R

Target T_4 is observed 15° L of T_1 at a range of 1550^{x}

Exterior angle is 55°

$$\therefore\ T_4\hat{B}\ O \text{ is } \frac{1550}{3220 + 1550} \times 55°$$

$$= 17° 50' \text{ R (by method B (2) } 17° 10' \text{ R)}$$

Then switch from T_1 = 10° 12′ L + 17° 50′ R

= 7° 38′ R

The figures shown as obtained by method B 2 are obtained with slide rule and are correct within 2′, thus disclosing large errors if method B. 3. is used in such a case.

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The use of the slide rule in method (2) is limited to finding the angles $T_2B\ O$, $T_3B\ O$, $T_4B\ O$. The method is simple and rapid, and is, of course, based on the usual formula

$$\tan \frac{B - T}{2} = \frac{b - t}{b + t} \times \tan \frac{B + T}{2}.$$

Procedure. Upset the slide and read angles on the "Tan" scale directly against yards on the "D" scale. (If angles are too small to be read on tan scale use the "sine" and "A" scales). Thus, for T_2 set 27° 30′ (half the exterior angle) over 3770 (the sum of the sides O T_2 and O B) and over 2670 (the difference of these sides) will be found 20° 15′ ($\frac{\hat{B}-\hat{T}}{2}$). Subtract this angle from 27° 30′ (the angle set against the sum of the sides) and the result 7° 15′ is the angle $T_2B\ O$ required. This is added to the original angle $T_1B\ O$ with sign reversed to obtain the switch.

NOTE.—If a slide rule is not available, (or if its use is disliked), the formula $\hat{B} = \frac{OT}{OT+OB} \times (180 - O)$ may still be used for large exterior angles provided the following correction is applied (When OT is greater than OB the formula, of course, becomes $\frac{OT}{OT-OB} \times O = (180 - B)$, but in this case O would generally be in or near the line BT, and the switch angle can easily be obtained by using the $\frac{D}{O}$ factor).

Both these formulæ make the lesser angle $\hat{B}$ or $\hat{T}$, (as the case may be), too great, and the greater angle too small by the same amount.

Our problem is to find $\hat{B}$.

A very close approximation of the error arising from the use of the above formulæ is obtained by taking 75% of the exterior angle in the former formula, (or 75% of the angle itself in the latter formula), and considering the number so found to be *minutes*. This amount must be deducted from the angle found by the formula whenever (as is usually the case), OT is less than OB. If OT is greater than OB it must be added. (Where OT and OB are nearly equal the apex angle can be best found by the $\frac{6}{10}$ rule).

The result in most cases will be within 10 minutes of the true angle.

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SOME OLD GUNNERY EXPERIMENTS.

By Major T. W. Saidler, R.G.A. (T.).

IN going over some old papers recently I came across a number which were of great interest from an artillerists point of view. They were carefully tied up, and labelled "Professor John Robison's calculations on the Carronade Practice at Leith Fort A.D. 1782" and contain a number of letters and papers relating to the introduction of the short light gun, afterwards known by the name "Carronade" which played such a large part in the armament of our warships in the sea fights about the end of the eighteenth, and commencement of the nineteenth, centuries.

This gun was the invention of Patrick Miller, Esq., of Dalswinton, a Banker in Edinburgh, best known by his having taken a considerable share in the introduction of steam navigation, having had one of the first practical steamboats ever built, running on a small loch on his Estate of Dalswinton, in Dumfriesshire. As well as steam navigation and gunnery, he seems to have turned his attention to improving the breed of horses, and other agricultural questions, so that he must have been a man of exceptional talent and versatility.

To arrange these papers in some kind of order, we may take first a letter from Mr. Jos Dawson the then manager of the Carron Ironworks near Falkirk, (from which the Carronade took its name) addressed to Mr. Miller (the son, I think, of the inventor).

Carron, April 25th, 1827.

Sir,

I duly received your letter of the 16th inst., and have since had several of our old Books examined, but no particular remarks respecting the carronades can be found in any of them. The first of these Pieces, as far as we can discover, was cast about the beginning of October 1778, at which period, and for some time subsequent, they are entered in some of the Books under the name of Cohorns, and in others under that of Carronades. They are first entered as Carronades in December 1778.

I am, Sir,

Your Most Obe. Sert.,

Jos Dawson.

Patrick Miller, Esq.

Edinburgh.

Then follows the Account incurred to the Carron Company for the Carronades, shot, "Magazine Articles" etc. used in the experiments, which is too long to be quoted in full, but from which the following may be excerpted—

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Patrick Miller, Esq., of Dalswinton.
Bot. of Carron Company.

		£	s.	d.	d.	£	s.	d.
1781								
Sept. 29	1 Carronade 100 pr. No. 38281 proved, with carriage (Compl.)	2	11	2		100		
	£ s. d.							
,,	6 Balls 100 pr. C5.1.12 @ 14/- 3 15 0							
,,	3 Hollow shot C2.0.22 }							
,,	1 Shell shot C2.2.26 } 2.3.20 @ 18/- 2 12 8							
,,	3 Canister shot... ...2.2.12 @ 21/- 2 14 9							
	£9 2 5					4	11	2
	N.B.—Half the value of the shot only to be placed to the debit of Mr. Miller because they were used at the Greenbrae trying experiments.							
,,	Magazine articles...					4	13	0
,,	For one half of the expences of experiments made at Greenbrae with the 100 pr. carronade. The Company pay the other half of said expence, amount per said note							
1782	£3 19s. 6d., his half is					1	19	9
June 6	1 Carronade 132 pr. No. 38403 proved with a carriage, *Skeed* (?), stool, platform and trucks £132 0 0							
	As the above carronade weighed only 2.11.2.14 in place of 2.18.3.20, the difference of weight, C7.1.6 to be deducted from the price @ 14/- per cwt. 5 2 2							
	. . . .					126	17	10
	Filling 30 of the above shell shot				2		5	0
	. . . .							
June 29	For half of the three following articles used at the experiment of the 132 Cade at the Greenbraes—							
	£ s. d. £ s. d.							
	98 lb. Gun Powder @ 1/4 6 10 8							
	Mens wages 2 0 8							
	Carriage of a platform from the Dockyard to Carronwharf 10 0							
	£9 1 4							
	One half of which ... 4 10 8							
	80 Priming wires for 6 pr. @ 1/- per dozen 6 8							
	80 Do. 32 pr. @ 2/- per dozen ... 13 4							
	8 Tin cases for said primers ... 12 0							
	. . . .					6	2	8

The Total of this Account, including various "pieces of Ballast" and "Keel pieces", (evidently items in connection with the steamboat side of Mr. Miller's activities) amounted to £449/0/3 so that the cost of the experiments cannot be said to have been excessive, and will fill a Modern Artilleryman with envy!

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No trace of the "Greenbrae" Experiments exists among the papers, but elaborate notes remain of practice carried out at Leith Fort, which was at that time close to the sea, and not separated from it by reclaimed ground on which the Caledonian Railway Goods Yard now stands.

The first of these practices appears to be the "Calibration" to use the present term, of a 100 pd. Carronade on 16th Jan., 1782.

Expts. Jan 16, 1782.

Carronade of 100 lb. ball—weighing 46 cs.
13 inch Mortar, shell 190 lbs.

Expt.	Nature of shot.	Charge.	Elevn.	Angle at Gun.	Angle at Pier.	Range.
1	103	7	4[illegible]	46.22	121.26	3621.32"
2	190	7	45	45.12	105.40	1762
3	103	8	45	44 18	125.45	4171.34"
4	103	10	45	41.32	129.12	4272.26"
			July 11, 1782, Carronade 132 lbs.			
1	132	7	45.15	50	116.26	3153
2	shell	7	44.45			
3	132	7	44.45	51.18	116.26	3481
4	132	8	32	46.27	128.42	2827

In regard to the first Series, the "Range Officer" remarks,

No. of Experiment.

1. This shot pointed at the Beacon, fell 2° 20′ to the west of it from the pier. 32 seconds in the air.
2. The 13in. shell fell 1° 10′ to west of Beacon. Seconds in in the air not reported.
3. This shot fell about 10′ west of Beacon and reported 34 seconds in the air.
4. This shot fell 2° 36′ to the east of Beacon and reported 36 seconds in the air.

In the above experiments the Carronade was stuck in the ground, and the 13 inch Mortar mounted on the usual carriage.

On the whole, the "Experiments" are not so unlike a Calibration Series in a present day Gunnery School, and prove that "Calibration" is perhaps not so great a novelty as its advocates would have us believe, although I do not think many of them would have the courage to endeavour to calibrate a 100 pdr. Carronade, and a 13 inch Mortar in one Group!

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INDEX—VOL. XLV.

A.

Action performed by the artillery of V. Army; by Maj.-Genl. H. C. C. Uniacke, C.B., C.M.G. 255
Aeroplane observation, a note on ranging with; by Major R. Withers, D.S.O., R.G.A. 287
Apparatus, simple, for instructing gun layers; by Capt. R. V. Walling, R.G.A. 283
Appreciation; Genl. Sir R. Biddulph, G.C.B., etc. 317
Arbuthnot, General; discussion, Col. Hobday's lecture on History of R.A. ... 21
Arbuthnot, General; discussion, Col. Hobday's lecture on Horse Management 59
Artillery, short chronology of events connected with the material of, down to 1886; by Lt.-Col. H. W. L. Hime, late R.A. 175
Artillery instruments not of service type; by Major L. A. Notcutt, M.C., R.A. 222
Artillery, trench; remarks on 245
Artillery training 301, 350
Artillery, field, from trench to open warfare on the Western front; by Lt.-Col. W. H. F. Weber, D.S.O., R.F.A. 357
Artillery graph; by Lieut. H. J. Fisher, Australian Field Artillery 314
Attack on an entrenched position, the modern; by Col. H. A. Bethell, C.M.G., R.A. 121
Artillery pack saddlery; by Capt. (Actg. Maj.) F. C. A. Troup, R.G.A. 393

B.

Beams in dug-outs; by Lieut. E. S. Stanley, R.G.A. 188
Bethell, H. A., Col., C.M.G., R.A.; the modern attack on an entrenched position 121
Bethell, H. A., Col., C.M.G., R.A.; discussion, Major Maitland-Addison's lecture 149
Biddulph, Sir Robert, Genl., G.C.B., etc.; an appreciation 317
Booth, L. E., Major, M.C., R.F.A.; drift with the 4.5″ howitzer 134
Brain *v.* Rule of thumb; by Major A. E. C. Myers, R.G.A. 87
Brown, P. W. F., Lieut., R.G.A.; displacement corrections 164
Brown, P. W. F., Lieut., R.G.A.; driving band gauges 164
Butterworth, B. M. G., Capt., M.C., R.G.A.; relative calibration by the corrector 60

C.

Calculations necessary for the construction of dug-outs; by Major F. M. G. Du Plat Taylor, R.G.A. 107
Calibration by the corrector; by Capt. B. M. G. Butterworth, M.C., R.G.A.... 60
Calibration in the field, comparative; by Major C. Q. L. Penrose, M.C., R.G.A. 130
Campbell, J. P., 2nd Lieut., R.F.A.; dispersion or concentration rule 180
Campbell, J. P., 2nd Lieut., R.F.A.; ranging on line of observation 178
Chronology of events connected with the material of artillery down to 1886; by Lt.-Col. H. W. L. Hime 175
Cleeve, W. F., Maj.-Genl., C.B.; Chairman, Col. Hobday's lecture 1, 20
Cleeve, W. F., Maj.-Genl., C.B.; Chairman, Genl. Stone's lecture 28, 37
Cleeve, W. F., Maj.-Genl., C.B.; discussion, Major Maitland-Addison's lecture 148, 149
Cloeté, E., Col.; discussion, Col. Hobday's lecture 59
Corrections, displacement; by Lieut. P. W. F. Brown, R.G.A. 164

D.

Displacement corrections; by Lieut. P. W. F. Brown, R.G.A. 164
Drift with the 4.5″ howitzer; by Major L. E. Booth, M.C., R.F.A. 134
Driving band gauges; by Lieut. P. W. F. Brown, R.G.A. 164
Dug-outs, calculations necessary for the construction of; by Major F. M. G. Du Plat Taylor, R.A. 107
Du Plat Taylor, F. M. G., Major, R.G.A.; calculations necessary for the construction of dug-outs 107
Dunn, K. F. W., Capt., R.F.A.; notes on identification of points 117

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E.

Echoes from the mess table—and elsewhere; by "Henry Clay" 325, 363
Employment of officers in topographical surveying; by Major R. H. Rowe, D.S.O., M.C., R.G.A. 387
Energy contained in a charge of .303" Mark VII. cartridge, distribution of; by Major J. H. Hardcastle, R.A. 157
England, the German invasion of, X. to XVI. centuries; by Brig.-Genl. F. G. Stone, C.M.G. 338
Exercises, tactical, without troops; by Maj.-Genl. H. C. C. Uniacke, C.B., C.M.G. 334

F.

Fisher, H. J., Lieut.; artillery graph 314
Fogerty, J. F., Major, R.F.A. (T.); illustrations to "Gaudia Centurionis" ... 375
Ford, B. J. T., Major; indoor gunnery 24

G.

Gauges, driving band; by Lieut. P. W. F. Brown, R.G.A. 164
German invasion of England, X. to XVI. centuries; by Brig.-Genl. F. G. Stone, C.M.G. 338
Graph, artillery; by Lieut. H. J. Fisher, A.F. Artillery 314
Grid, the simplest and most accurate form of; by Major E. H. Lovell, R.G.A. 169
Gun, the long range; a lecture by Major J. Maitland-Addison 137
Gun pits, calculations necessary for construction of; by Major F. M. G. Du Plat Taylor, R.G.A. 107
Gunners' rule 63, 182, 185
Gunnery, indoor; by Major B. J. T. Ford 24
Gaudia Centurionis, or the Instructor of Zeitûn; illustrations by Major J. F. Fogerty, R.F.A. (T.); verses by Lieut. H. C. Hughes, R.F.A. (T.) ... 375

H.

Hardcastle, J. H., Major, R.A.; the distribution of the energy in a cordite charge for a .303" Mark VII. cartridge 157
Hare, C. E., Major, M.C., R.G.A.; notes on the use of Swayne's sheets 201
Headlam, J. E. W., Maj.-Genl., C.B., D.S.O.; ordnance on the allied fronts ... 209
Hezlet, R. K., Lieut.-Col., D.S.O., R.A.; what is a nomogram? 330
Hime, H. W. L., Lt.-Col.; remarks on the Vice-President's appeal to members of R.A.I. 323
Hime, H. W. L., Lt.-Col.; short chronology of events connected with material of artillery down to 1886 175
Hobday, E. A. P., Col., C.M.G., R.A.; history and traditions of the R.A.—a lecture 1, 21
Hobday, E. A. P., Col., C.M.G., R.A.; horse management in the field—a lecture 41, 58, 59
Hutchison, A., Lieut.; notes on the errors of vertical vase range finders 151
Hutchinson, F. P., Lt.-Col., D.S.O., R.G.A.; The battle in Palestine, 19th August, 1918 370
Hughes, H. C., Lieut., R.F.A. (T.); Gaudia Centurionis, or the Instructor of Zeitûn 375

I.

Identification of points, notes on; by Capt. K. F. W. Dunn, R.F.A. 117
Instruments, artillery, not of service type; by Major L. A. Notcutt, M.C., R.A. 222

J.

Jerusalem, the taking of 295
Journal of the Royal Artillery; Vice-President's appeal 253

L.

Laying for line, the bearing method of; by Capt. L. A. Notcutt, M.C., R.G.A. 65
Layers, gun, simple apparatus for instructing; by Capt. R. V. Walling, R.G.A. 283

Digitized by Google

Liaison 165
Lille, the official entry of the V. Army Commander into 292
Lecture on the history and traditions of the R.A.; by Col. E. A. P. Hobday, C.M.G., R.A. 1
Lecture on Prussia's part in the seven years' war; by Brig.-Genl. F. G. Stone, C.M.G. 28
Lecture on horse management in the field; by Col. E. A. P. Hobday, C.M.G., R.A. 41
Lecture on the long-range gun; by Major J. Maitland-Addison, R.A. 137
Lovell, E. H., Major, R.G.A.; the simplest and most accurate form of grid ... 169

M.

Mackey, H. J. A., Brig.-Genl., C.M.G., M.V.O., D.S.O.; sport in Mesopotamia ... 173
Macrae, A. E., Major, R.A.; surveys of the English coast, 1779-1793 ..... 73, 89
Maitland-Addison, J., Major, R.A.; the long-range gun—a lecture 137
Maps, locating positions on; by Major J. Powrie, R.H.A., H.A.C. 69
Mesopotamia, sport in; by Brig.-Genl. H. J. A. Mackey, C.M.G., M.V.O., D.S.O. 173
Mess table, echoes from the 325, 363
Myers, A. E. C., Major; brain *v.* rule of thumb 87

N.

Nomogram, what is a?; by Lieut.-Col. R. K. Hezlet, D.S.O., R.A. 330
Normand, Major S. R., D.S.O., R.G.A.; rapid calculation of switches from an O.P. without a map 397
Notcutt, L. A., Capt., M.C., R.A.; the bearing method of laying for line 65
Notcutt, L. A., Capt., M.C., R.A.; artillery instruments not of service type ... 222

O.

Observation, oblique; by Major S. R. Wason, M.C., R.A. 197
Old gunnery experiments; by Major T. W. Saidler, R.G.A. (T.) 402
Operations—Aug. 21 to Sept. 4, 1918; extracts from report on 289
Ordnance on the allied fronts; by Maj.-Genl. J. E. W. Headlam, C.B., D.S.O.... 209
Ordre general, No. 351—July 16, 1918 221

P.

Pack saddlery, artillery; by Capt. (Actg. Maj.) F. C. A. Troup, R.G.A. 393
Palestine, the battle in, Aug. 19, 1918; by Lt.-Col. F. P. Hutchinson, D.S.O., R.G.A. 370
Penrose, C. Q. L., Major, M.C., R.G.A.; comparative calibration in the field... 130
Perceval, Brig.-Genl.; discussion, Major Maitland-Addison's lecture 149
Plotter field, simplest form of, for quick work in the field; by Col. A. ff. Powell, D.S.O., R.A. 203
Powell, A. ff., Col., D.S.O., R.A.; ranging on line of observation without the use of factors 136
Powell, A. ff., Col., D.S.O., R.A.; simplest form of plotter for quick work in the field 203
Powrie, J., Major; locating positions on maps 69

R.

Range, miniature, a useful accessory to; by Major W. H. Wilson, D.S.O., R.F.A. 39
Range, correction of, when firing with angle of sight; by 2nd Lieut. F. G. Soper, R.G.A. 205
Range finders, vertical base, notes on errors of; by Lieut. A. Hutchinson ... 151
Ranging on the line of observation without the use of factors; by Col. A. ff. Powell, D.S.O., R.A. 136
Ranging on line of observation; by Lieut. J. P. Campbell, R.F.A. 180
Ranging with aeroplane observation; by Major R. B. Withers, D.S.O., R.G.A.... 287
Rapid calculation of switches from an O.P. without a map; by Major S. R. Normand, D.S.O., R.G.A. 397
Ready reckoner for wind corrections; by 2nd Lieut. F. G. Watts, R.G.A. 186
Richardson, Maj.-Genl. J. B., Col. Comdt., R.A.; a tough lot 390
Rowe, Major R. H., D.S.O., M.C., R.G.A.; the employment of officers in topographical surveying 387
Rule, the gunners' 63
Rule, distribution or concentration; by 2nd Lieut. J. P. Campbell, R.F.A.... 180
Rule of thumb *v.* brain; by Major A. E. C. Myers, R.G.A. 87

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S.

Saidler, Major T. W., R.G.A. (T.); some old gunnery experiments 402
Section commander; by Maj.-Genl. H. C. C. Uniacke, C.B., C.M.G. 285
Soper, F. G., 2nd Lieut., R.G.A.; correction to range when firing with angle of sight 205
Sport in Mesopotamia; by Brig.-Genl. H. J. A. Mackey, C.M.G., M.V.O., D.S.O. 173
Stanley, E. S., 2nd Lieut., R.G.A.; built-in beams in dug-outs 188
Stokes, A., Brig.-Genl., C.B., C.M.G., D.S.O.; chairman, Col. Hobday's lecture 41, 59
Stokes, A., Brig.-Genl., C.B., C.M.G., D.S.O.; chairman, Major Maitland-Addison's lecture 137
Stone, F. G., Brig.-Genl., C.M.G.; Russia's part in the seven years' war—a lecture 28
Stone, F. G., Brig.-Genl., C.M.G.; the German invasion of England, X. to XVI. centuries 338
Sums in the field; by Major S. R. Wason, M.C., R.H.A. 189
Surveys of the English coasts, 1779-1793; by Major A. E. Macrae, R.A. ... 73, 89
Swayne's sheets, notes on use of 201
Switches, rapid calculation of; by Major S. R. Normand, D.S.O., R.G.A. 397

T.

Tactical exercises without troops; by Maj.-Genl. H. C. C. Uniacke, C.B., C.M.G. 334
Training, artillery 301, 350
Trench artillery, remarks on 245
Tough lot; by Maj.-Genl. J. B. Richardson, Col. Comdt., R.A. 390
Troup, Capt. (Actg.-Maj.), F. C. A., R.G.A.; artillery pack saddlery 393

U.

Uniacke, H. C. C., Maj.-Genl., C.B., C.M.G.; actions performed by the artillery of the V. Army 255
Uniacke, H. C. C., Maj.-Genl., C.B., C.M.G.; the section commander 285
Uniacke, H. C. C., Maj.-Genl., C.B., C.M.G.; extracts from reports on operations, Aug. 21 to Sept. 4, 1918 289
Uniacke, H. C. C., Maj.-Genl., C.B., C.M.G.; tactical exercises without troops 334

W.

Walling, R. V., Capt.; a simple apparatus for instructing gun layers 283
Wason, S. R., Major, M.C., R.H.A.; sums in the field 189
Wason, S. R., Major, M.C., R.H.A.; oblique observation 197
Watts, F. G., 2nd Lieut., R.G.A.; ready reckoners for wind corrections..... 186
Weber, W. H. F., Lt.-Col., D.S.O., R.F.A.; with the field artillery from trench to open warfare on the western front 357
Wilson, W. H., Major, D.S.O., R.F.A.; a useful accessory to a miniature range 39
Wind correctors, ready reckoners for; by 2nd Lieut. F. G. Watts, R.G.A..... 186
Withers, R. B., Major, D.S.O., R.G.A.; a note on ranging with aeroplane observation 287

End of Volume XLV.

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62

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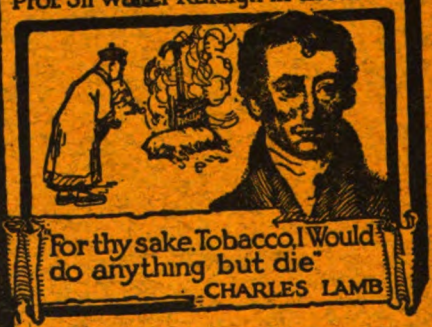

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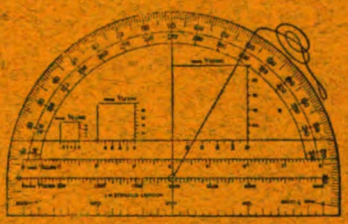

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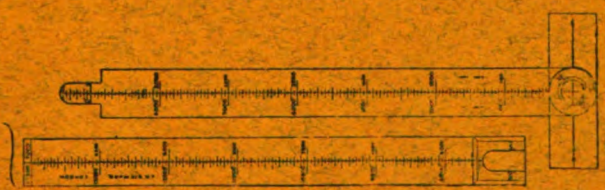

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